Chapter 6

6.0 AFFECTED ENVIRONMENT

6.1 GENERAL ENVIRONMENT/NATURAL RESOURCES

This section of the FEIS provides a brief overview of the general environment and natural resources on the Empire Tract and adjacent areas. It also describes the relationship of the Empire Tract to the natural resources of the surrounding area. The following sections on natural resources such as wetlands, water quality, and wildlife provide more detailed discussions of these resources.

The Empire Tract encompasses approximately 587 acres of undeveloped, privately owned land located within the Boroughs of Carlstadt and, Moonachie and the Township of South Hackensack in Bergen County, New Jersey (Figure 4.1-1). The tract is located approximately 5 miles west of Manhattan and lies immediately northeast of the Meadowlands Sports Complex, adjacent to the western spur of the New Jersey Turnpike. The northeastern border of the tract is formed by the Hackensack River, which is tidal and flows in a southerly direction into Newark Bay, approximately 7 miles downstream.

6.1.1 Regional Setting

6.1.1.1 Natural History

The Empire Tract is located within the northern portion of the Hackensack Meadowlands District (HMD). The HMD is a 32-square-mile area administered by the New Jersey Meadowlands Commission (NJMC) (Section 4.1), and includes an estimated 8,500 acres of freshwater non-tidal and estuarine tidal wetlands associated with the Hackensack River (see Section 6.2).

The HMD is located within the 200-square-mile Hackensack River Basin that was formed thousands of years ago by scouring from glacial ice (USEPA and USACE 1995). As the glaciers retreated, melting ice caused rising sea levels to flood much of the basin, forming glacial Lake Hackensack. As the glacial lake drained (about 14,000 years ago) and sea levels continued to rise, an estuary developed. Wetlands formed within the low-lying areas, including tidal wetlands associated with the Hackensack River. Several changes in the composition and extent of these wetlands have occurred over time (see Section 6.2). Today, many of the remaining wetlands consist of brackish tidal marsh and open-water areas associated with the Hackensack River estuary. A more detailed description of the geology, topography, and soils of the area is provided in Section 6.12.

6.1.1.2 Human Influence

The Hackensack River estuary is part of the larger New York-New Jersey Harbor estuary system, which includes Newark Bay; the lower Hudson, Passaic and East Rivers; the Arthur Kill; the Kill Van Kull; Upper and Lower New York Bay; and Raritan Bay. Historically the New York-New Jersey Harbor estuary has experienced severe water quality degradation resulting from human activities. Due to improved sewage treatment facilities, landfill practices and point-source controls, water quality in the region has improved over the last two decades, benefiting fish, wildlife, and other resources (Crawford et al. 1994). However, the New York-New Jersey Harbor estuary is still considered one of the most polluted in the nation (USEPA 1997). Section 6.3 discusses regional water quality in detail.

Human activities have also substantially changed the hydrology of wetlands in the harbor estuary, as well as adjacent freshwater wetlands. Dams, such as the Oradell Reservoir Dam, changed the volume of freshwater entering the Hackensack River. Ditches were dug, dikes constructed, and wetlands were filled to make the land suitable for development. Within the Hackensack Meadowlands itself, an estimated 12,000 acres of the original wetlands have been filled (USFWS 1996). Changes in the hydrology of the wetlands from filling or draining have led to direct losses or modification of wildlife habitat. These changes also have altered the species composition of the remaining ecological communities and decreased their value as habitat for wildlife (Crawford et al. 1994).

Although wetlands and other habitats within the HMD have undergone severe environmental stress over the past two decades, positive environmental changes have occurred within the HMD (Crawford et al. 1994). Water quality within the Hackensack River has improved, and several landfills have been closed and capped. Due to regional improvements in environmental quality and other initiatives, some species such as the peregrine falcon have begun to rebound. Human influence on wetland communities is discussed in detail in Section 6.2, while fish and wildlife communities are discussed in Section 6.4 and Section 6.5, respectively.

6.1.1.3 Values for Humans and the Environment

The Hackensack Meadowlands represent the largest remaining brackish wetland complex in northern New Jersey (Tiner 1985). Although these wetlands have been affected by surrounding urbanization, they continue to be of value. For the purposes of this EIS, "functions" are the processes performed by wetlands, while "values" are the worth that society places on those functions. Wetland functions include the ability of wetlands to filter out pollutants from the water with which they come into contact. Wetlands also provide habitat for fish and wildlife. They provide temporary storage of storm water that might otherwise cause flooding, and may provide recreational opportunities for the public.

The Hackensack Meadowlands are located within an important migratory bird route, the Atlantic Flyway. The Meadowlands also contain a substantial amount of open-water habitat within the otherwise heavily developed northeastern New Jersey-New York metropolitan area. Because of these characteristics, the Hackensack Meadowlands are, in general, considered an important habitat for migratory birds such as waterfowl, shorebirds, and a variety of other species. In recognition of their importance, the USEPA has listed the Hackensack Meadowlands as a National Priority Wetland. The national priority list does not create federal enforcement authority, but it does identify areas that USEPA believes are important resources (USEPA and USACE 1995). Through the USEPA-sponsored New York-New Jersey Harbor Estuary Program, by which harbor water quality is monitored, the Hackensack Meadowlands also has been designated as a "Regionally Significant

Habitat Complex" (USEPA and USACE 1995). This designation has no official regulatory effect. The Hackensack Meadowlands wetland complex also qualifies as an Aquatic Resource of National Importance (USACE 1994). The findings and recommendations of these programs will be considered in the public interest review conducted for the Empire Ltd. application, in relation to both site-specific and regional impacts anticipated from the applicant's proposal.

6.1.2 Empire Tract

The 587-acre Empire Tract consists of approximately 569 acres of wetlands and other aquatic habitats, and 18 acres of upland area (TAMS 1998). The site contains approximately 6.7% of the total amount of wetlands in the HMD. The site consists of two parcels: a 42-acre parcel located along the Hackensack River east of the New Jersey Turnpike, and a 545-acre parcel located immediately west of the New Jersey Turnpike. The entire site is located within the 100-year floodplain mapped by the Federal Emergency Management Agency (FEMA) (Figure 6.1-1).

Three creeks cut through the wetlands on site: Bashes Creek, Moonachie Creek, and Muddabach Creek (Figure 6.1-2). These creeks flow very slowly in an easterly direction into the Hackensack River. A fourth creek, Losen Slote, is located along the northeastern edge of the property, and also flows into the Hackensack River.

Historically, most of the wetlands present on site were tidal marsh and associated tidal creeks flooded by waters from the Hackensack River. However, the construction in the early 1900s of tidal gates along Losen Slote, Moonachie and Muddabach Creeks, as well as berms and a large embankment along the New Jersey Turnpike, prevented the majority of the site from being regularly flooded by the tides, a condition that persists currently. Because of this construction, the Empire Tract wetlands derive their water primarily from surface water flows and direct precipitation, with a lesser volume coming from creek surface water discharge of groundwater originating in the adjacent upland areas.

The vegetation of the Empire Tract has been influenced by historical conditions, including the restriction of tidal flows. While several habitat types were identified on the Empire Tract based on vegetation characteristics (Section 6.2), a single species known as common reed (*Phragmites communis*) dominates approximately 90% of the site, including both wetland and upland areas (Figures 6.1-3 and 6.1-4).

6.1.3 Regional and Site Hydrology

Hydrology is defined as "a science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere". Circulation, which is known as the hydrologic cycle, is an attempt to describe the pathways of water as it moves physically through the environment, and the means by which it is used by plants and animals. Studies of hydrology include both surface water hydrology and groundwater hydrology. A discussion of site hydrology is provided herein to help in understanding its importance in influencing the wetland functions with respect to fish and wildlife habitat, water quality improvement, flood storage and social significance.

Surface water hydrology encompasses two facets of almost all projects: the study of the natural system and the study of the engineered system. The purpose of these studies is to 1) determine the characteristics of the existing natural system, and 2) determine if the engineered system will replicate or mitigate important facets of the natural system.

An understanding of the hydrology of the Empire Tract is important in the evaluation of existing natural resources, their potential value, and potential project impacts. The hydrological characteristics of the Empire Tract are influenced by the following:

- the site is located within the 100-year floodplain of the Hackensack River;
- the site consists primarily of common reed wetlands;
- primary water input to the site is from precipitation and storm water runoff from the surrounding developed watershed;
- tidal flow to the site is restricted by a series of tide gates and berms;
- some of the tide gates may occasionally leak under certain circumstances, allowing Hackensack River water to enter the on-site creeks; and
- the site is located within and is part of the Hackensack River ecosystem.

6.1.3.1 Regional Hydrologic Cycle

The regional hydrologic cycle (see Figure 6.1-5) begins with evaporation of water from oceans and lakes, with the resulting water vapor being transported by moving air masses. Under the proper conditions, the water vapor will condense into clouds, which may in turn produce precipitation. The form of the precipitation (rain, snow, ice, etc.) has an influence on what happens to the precipitation as it falls to the ground, as does the condition of the ground on which it falls. For example, snow falling on a frozen ground surface will accumulate, while snow falling on a warmer ground surface will melt. When rain falls on open ground (lawns, forests, etc.), it can be absorbed into the surface soils or run off the ground surface into streams and creeks.

Precipitation may infiltrate the surface soils and move downward to become groundwater, evaporate from the ground surface, or be intercepted by plants, and eventually used by animals. Just as water used by animals is returned to the atmosphere by perspiration, plants release water back into the air by a process called transpiration. The precipitation that has infiltrated into the ground may ultimately reach or percolate into the "water table." The water table is the boundary between the shallow zone of unsaturated soils, and deeper soils saturated with groundwater. The saturated groundwater zone may be considered an "aquifer" if a sustainable amount of fresh water can be drawn from supply wells for use. Water that reaches the water table enters this saturated zone, or aquifer, and begins to flow with the groundwater. Groundwater moves downhill like a stream (only much more slowly) and may eventually discharge into streams, lakes, rivers, or the ocean.

The hydrologic cycle, while continuously in motion, is not steady. For example, annual and seasonal variations in precipitation can influence flooding and groundwater levels. Understanding the extreme facets of the hydrologic cycle (e.g., flood events) enables prediction of a potential range of project impacts under different scenarios.

100-Year Floodplain in the Hackensack Meadowlands District

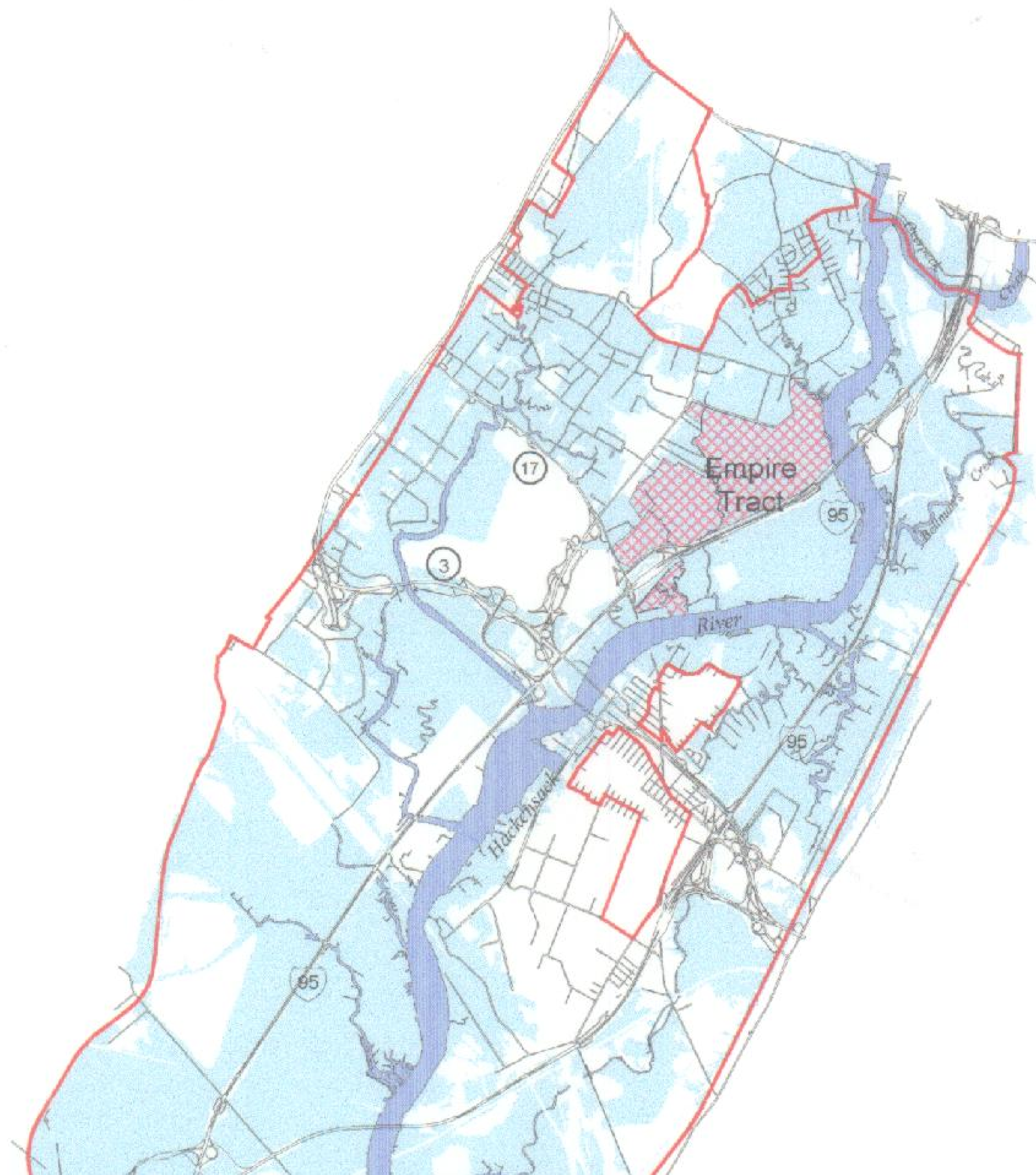


Figure 6.1-1

Source: Adapted from TAMS (1998).

Surface Waters of the Empire Tract

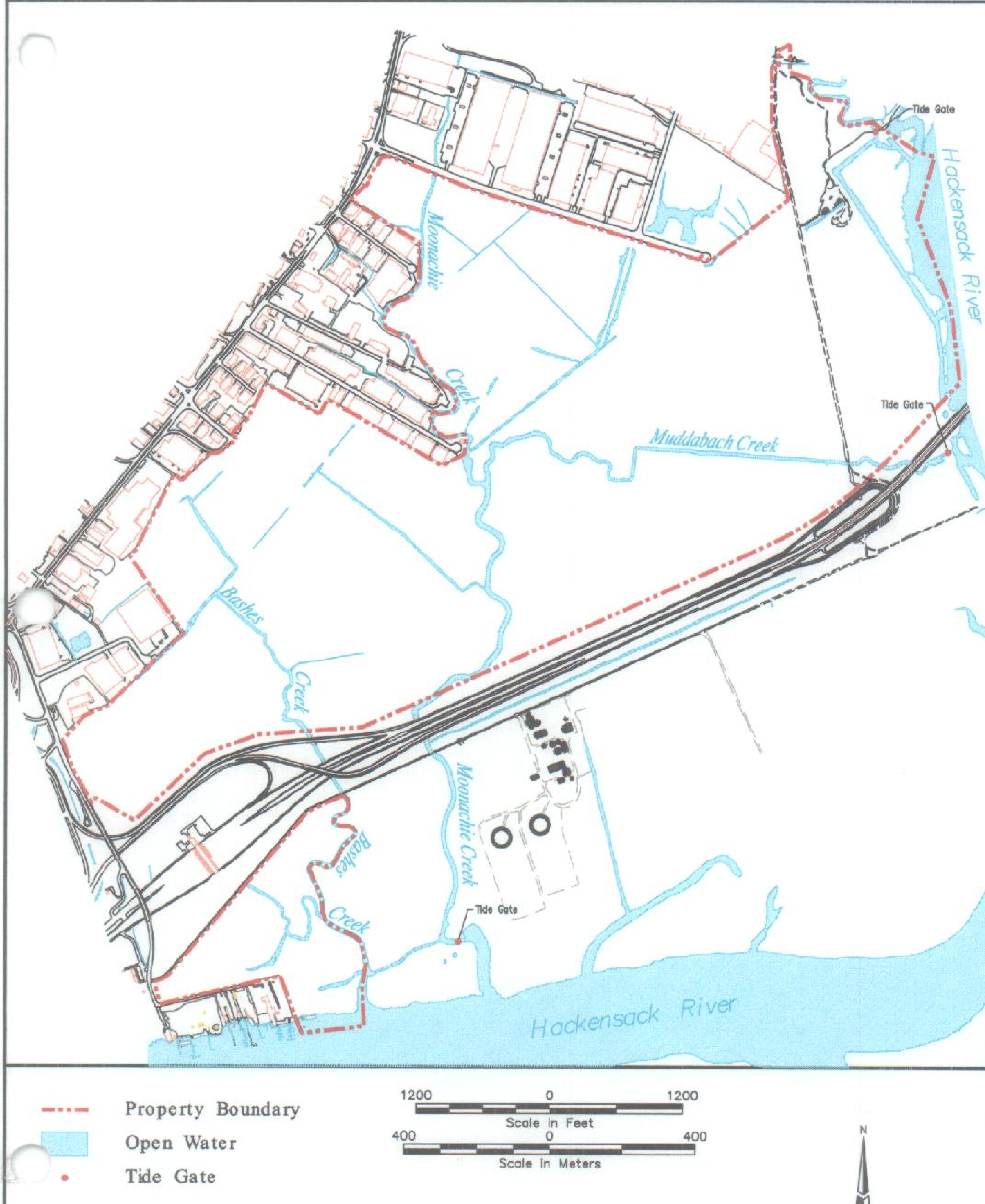
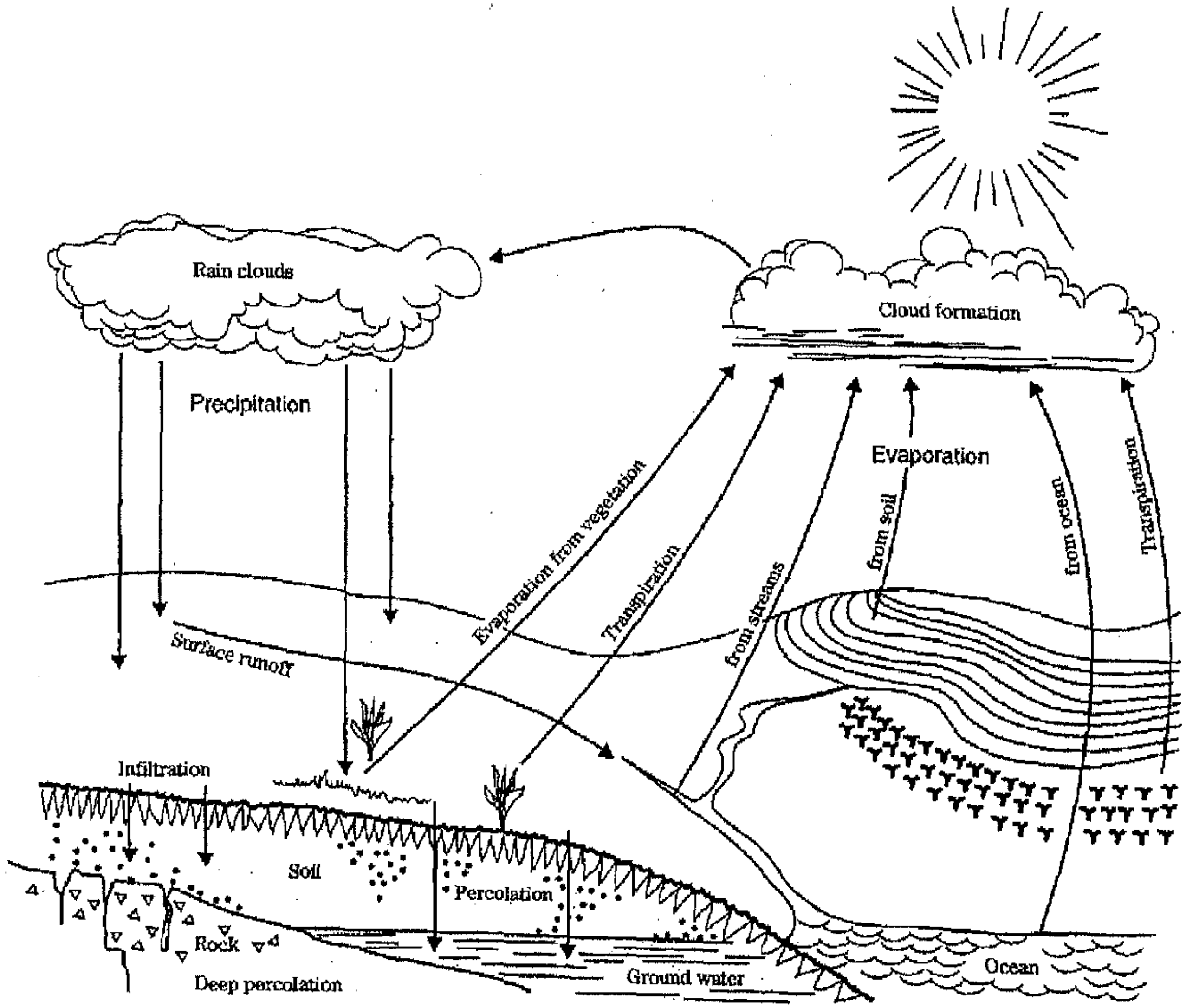


Figure 6.1-2

Figure 6.1-3 Empire Tract Facing North

Figure 6.1-4 Bashes Creek Facing East

Hydrologic Cycle



Water Surface

Source: Adapted from NRCS (1997)

Figure 6.1–5

6.1.3.2 Hydrologic Cycle of the Empire Tract

In the local setting of the Empire Tract, certain processes described in Section 6.1.3.1 tend to dominate the local hydrologic cycle. As depicted in Figure 6.1-6, the local hydrologic cycle is dominated by runoff from the developed upland area into the creeks, direct precipitation falling onto the wetlands, transpiration from the wetlands, infiltration to groundwater, evaporation from large open water bodies, and the general flow of surface water to and from the tidally influenced Hackensack River.

The Empire Tract wetlands appear to receive most of their water input from precipitation falling directly on the wetlands. Data collected on the site have shown that shallow groundwater levels respond directly to a precipitation event (PS&S 2000 PS&S 2001a). Review of information collected by the applicant at the request of USACE indicates that groundwater levels increase rapidly in response to major rain events (PS&S 2000).

Surface water levels vary seasonally, primarily in response to storm events but also depending on groundwater levels and tidal conditions. Precipitation falling in the watershed on impervious surfaces such as asphalt roads, concrete sidewalks and roofs is often conveyed to catch basins in the roads or other engineered drains to prevent flooding by the accumulating water. In such cases, this water, termed "storm water runoff," does not infiltrate the ground surface and most often is allowed to drain directly into natural creeks or streams, or into manmade "drainage swales" designed specifically to receive this water. Accordingly, runoff is much greater in developed areas. Not only is the amount of runoff greater, but the water tends to run off more quickly than in vegetated areas where infiltration into the soil occurs. As a result, runoff may cause flash flooding.

The effect of tides is another important influence on regional surface water elevations and flow patterns. Tides may directly influence regional flooding, as well as the nature of ecological communities that may develop on a site. Section 6.12 discusses regional flooding issues in detail.

Groundwater levels throughout the wetlands on the Empire Tract fluctuate with rainfall and other seasonal or climatic factors such as temperature, evaporation, and vegetative growth (PS&S 2000, PS&S 2001a). During the growing season (spring and summer), groundwater levels have been shown to be at their lowest due to the groundwater uptake by vegetation and subsequent evapotranspiration, as well as higher ambient temperatures and resultant evaporation. During the fall and winter seasons, when vegetation is dormant and temperatures are lower, the groundwater levels have been shown to be at their highest, and are close to the surface of the wetlands.

Groundwater levels in wetlands immediately adjacent to the Hackensack River may fluctuate in response to tidal conditions. During high tides, river water infiltrates the riverbank, and groundwater levels rise in areas immediately adjacent to the river. Upon return to low tide, the groundwater levels adjacent to the river fall again as the groundwater drains back into the river. This is a local effect, occurs notwithstanding the existence of tide gates, and does not extend onto the Empire Tract for a distance of more than several hundred feet, as evidenced by groundwater elevation data. Thus, direct exchange between the Hackensack River and adjacent wetlands on the Empire Tract is thought to be limited.

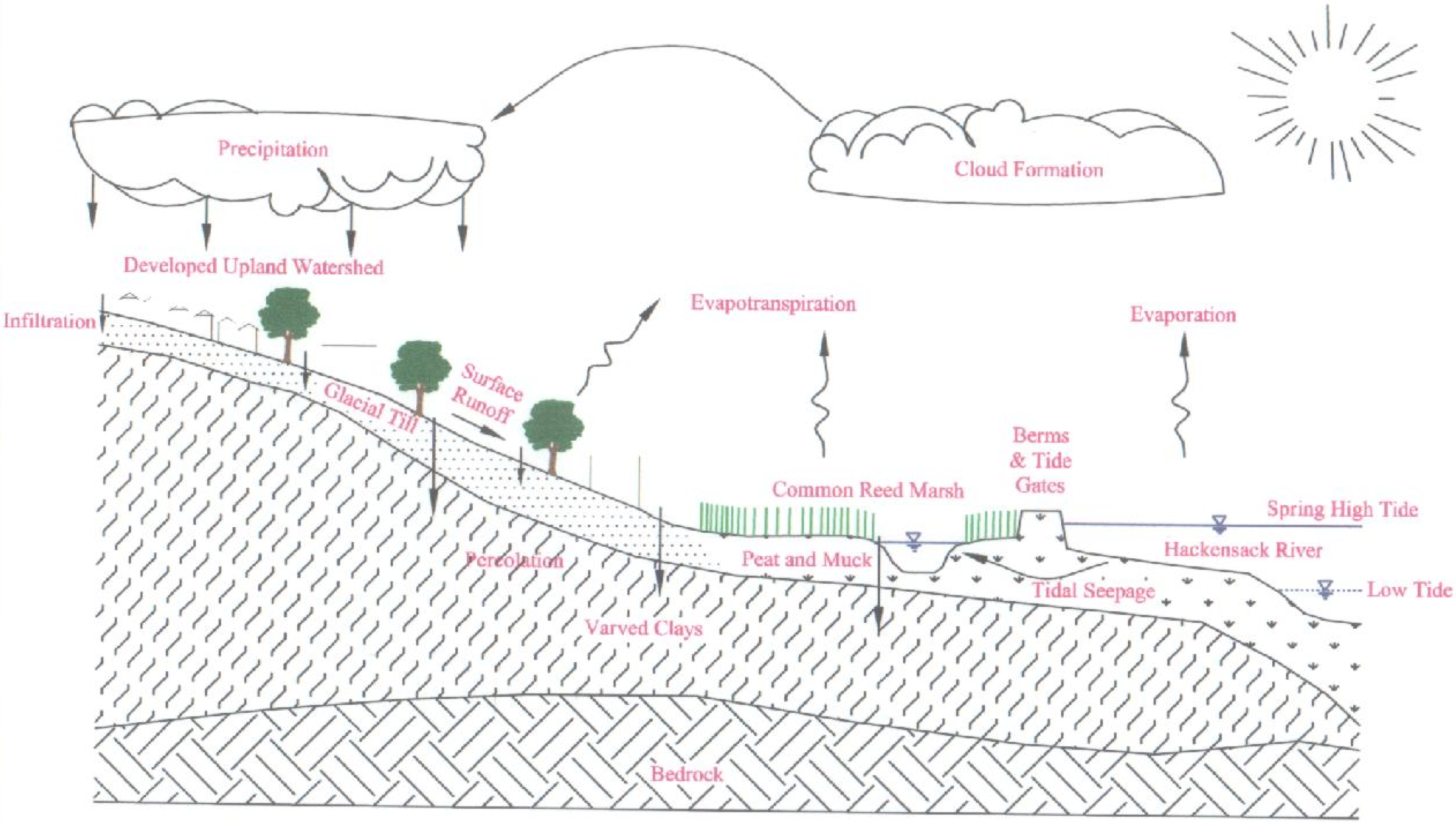
The hydrological data collected on the Empire Tract indicate that the wetlands on the site are seldom inundated, but that they may occasionally receive groundwater flow from the creeks that are present on site, and thus indirectly may receive some flow from the Hackensack River. The shallow groundwater elevation data indicate that this exchange decreases as one moves away from site creeks. Thus, while the influence of the Hackensack River on site hydrology has been diminished by flood gates, the potential does exist for water in the site creeks to move laterally from the creeks into adjacent wetlands on site (PS&S 2001b).

While the surface water in the creeks is thought to arise primarily from upgradient sources (e.g., storm water flows from the developed watershed above the Empire Tract), it also consists of water draining from the Empire Tract (as indicated by its dark reddish-brown color during storm events), and Hackensack River water that periodically leaks through tide gates. The frequency and extent of the tide gate leakage is unknown, but salinity measurements taken of site creeks indicate that there is a likelihood of some exchange. Because of the occasionally leaking tide gates, river water can apparently move into on-site creeks and move laterally into adjacent wetlands when wetland groundwater levels are lower than the creek water levels. Studies of the permeability of creek banks and bottoms completed in 2001 indicate some exchange of water occurs between the creeks and the adjacent wetlands groundwater, along the creek bottom and banks (PS&S 2001b). Directly adjacent to the creeks, groundwater levels may fluctuate in response to the rise and fall of surface water levels due to storm water runoff from upland areas, and from tidal effects in the creeks. The factors that determine the extent of this exchange include;

- the permeability of the wetlands soils;
- the permeability of the sediment lining the bottoms and banks of the surface water bodies; and
- the hydraulic gradient, or the difference in water levels between the wetlands and the surface water bodies.

Based on studies conducted on the Empire Tract, the greatest potential for exchange of shallow groundwater in the wetlands and the surface water in the creeks appears to be when either groundwater or surface water levels are at their highest (i.e., when the hydraulic gradient between the wetlands and creeks is the greatest) (PS&S 2001b). For groundwater, this occurs in the late fall and winter. For surface water, this occurs during extreme storm events and high river tidal conditions. The site investigations suggest that discharge occurs when the creeks rise for one to two days during the rain event, then return to their normal levels. Groundwater levels in the interior of the site (e.g., wells located 500 ft away from any creek) have shown little or no response to changes in creek levels. During the summer months when the greatest potential for water flow from the creeks into the wetlands exists (Section 6.2), groundwater levels in interior wells were sustained at levels significantly lower than the nearby creek levels. Sections 6.2 and 6.12 provide additional description of the site hydrology.

Hydrologic Cycle of the Empire Tract



Water Surface

Source: Adapted from URS Greiner (1997)

Figure 6.1–6

Section 6.1 References

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6.2 WETLANDS AND OTHER SPECIAL AQUATIC SITES

6.2.1 Overview

6.2.1.1 Definitions

USACE defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR §328.3). Wetlands generally include swamps, marshes, bogs, and similar areas.

Special aquatic sites are defined as geographic areas that possess "special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas generally are recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region (40 CFR §230.3 [q-1])." Specifically, the *Guidelines for Specification of Disposal Sites for Dredged or Fill Material (404(b) 1 Guidelines)* document identifies sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes as special aquatic sites (40 CFR §230 Subpart E).

6.2.1.2 Wetland Functions and Values

Wetlands may provide a variety of ecological and socioeconomic values (Tiner 1985). Wetland functions refer to the physical, chemical and biological interactions within wetlands (Reimhold 1992; NRC 1995). Functions often performed by wetlands include flood protection, erosion control, groundwater recharge, water quality improvement and fish or wildlife habitat. These functions usually vary with the type of wetlands present. Both site-specific and regional factors may be important influences on how a wetland functions, as well as the value of that wetland to society and the regional ecosystem.

Assessment of wetland functions and values are an important element in the process of assessing the environmental impacts of projects that propose to fill or alter wetlands. Wetland assessment methodologies provide an objective basis for providing such assessments. Wetland assessment methodologies can also provide information concerning the extent of wetland mitigation required to offset potential project impacts from filling or altering wetlands. A Memorandum of Agreement (MOA) between the USEPA and the United States Department of the Army sets forth as an objective of wetland mitigation the provision of "one for one" replacement of wetland functions lost as a result of development; that is, no net loss of wetland functions and values (USEPA and United States Department of the Army 1989). Although the MOA recognizes that *no net loss* of wetland functions and values may not be achieved in each and every permit action, a goal of the USACE regulatory program under the Clean Water Act is to contribute to the national goal of no overall net loss of the nation's remaining wetlands base. The MOA also states that wetland function should be assessed by applying aquatic site assessment techniques generally recognized by experts in the field or the best professional judgment of federal and state agency representatives (USEPA and United States Department of the Army 1989).

6.2.1.3 Wetland Functional Assessment Methodologies

Various wetland "functional assessment" methodologies have been developed. Results of wetland functional assessments are used by regulatory agencies in evaluating environmental impacts of human activities upon wetlands, identifying goals and objectives of mitigation or restoration programs designed to offset those impacts, and in some cases, monitoring the effectiveness of mitigation or restoration programs (Ainslie 1994, Brinson 1995, Wilson and Mitsch 1996).

The WET Assessment Method

At least 20 functional assessment models have been developed (Reimhold 1992). Many of the methods developed are "rapid assessment" measures that are important for timely application reviews under the Section 10/404 program (Ainslie 1994). Of these methods, one of the most widely used to date has been the Wetland Evaluation Technique (WET) model. The WET approach, developed by Adamus and Stockwell (1983), was one of the first comprehensive methods for evaluating wetland functions that has been broadly applied. Wetland functions identified by the WET model are summarized in Table 6.2-1.

Table 6.2-1
Wetland Functions Identified by the WET Functional Assessment Methodology

Groundwater Recharge Groundwater Discharge Flood Flow Alteration Sediment Stabilization Sediment/Toxicant Retention Nutrient Removal/Transformation	Production Export Wildlife Diversity/Abundance Aquatic Diversity/Abundance Recreation Uniqueness/Heritage

The WET model was intentionally developed as a rapid assessment measure for screening functional values of a specific site in the absence of detailed information concerning wetland processes of that site (Adamus and Stockwell 1983). Based upon available scientific research, wetland characteristics were related to wetland functions and processes to develop assessment indicators. Like any assessment methodology, the WET method has several limitations (Brinson 1995, Kusler and Niering 1998). First, the WET model was developed as a broad-based model for application to all wetlands within the United States (Adamus and Stockwell 1983) and was not directly applicable to specific types of regional wetlands (Brinson 1995). In addition, the WET method relies upon subjective evaluation of some functions, and identifies only *the probability* that a certain function or value is present as high, moderate or low (Adamus and Stockwell 1983, Brinson 1995). Finally, the WET model is not readily adaptable for use in determining wetland mitigation ratios. Usually, a mitigation ratio represents the number of acres required to be created, restored, or enhanced as compensation for an acre of existing wetland that would be impacted by the proposed project.

The WET model was used as a screening method by USEPA (1989) and USACE as part of an Advanced Identification Study (AVID) to identify potential locations in the HMD suitable or unsuitable for placement of fill material. An interagency team calculated and evaluated the scores for different wetland assessment areas within the HMD for use in regional planning under the then-proposed SAMP.

The Indicator Value Assessment Method

The interagency team subsequently developed the Indicator Value Assessment (IVA) approach to be applied specifically for the Hackensack Meadowlands. The IVA method was developed as a regional planning tool in order to quantitatively rank wetlands by their general value in order to evaluate different regional development scenarios, to evaluate potential mitigation needs, and to assess the potential of different wetlands for enhancement (Hruby et al. 1995). Since it is a numeric method the value of different assessment areas within the HMD relative to one another may be compared (see Figures 6.2-6 through 6.2-8).

The IVA is a rapid assessment method based upon the assumption that wetlands having specific chemical, physical, and biological functional indicators perform a given wetland function better than those that do not (Hruby et al. 1995). The IVA is based on the WET model criteria (Table 6.2-1), and utilizes data presented in the AVID study previously collected in the HMD (USEPA 1989). Unlike the WET method, which is qualitative in nature, the IVA method may be used to help quantify potential impacts caused by predicted changes to these indicators (USEPA et al. 1995). It also is regionally focused, and can be used to determine mitigation ratios on a regional basis.

Although the IVA method is more quantitative than the WET method, it is still mainly a ranking procedure designed for regional planning purposes. Quantitative scores determined using the IVA are not necessarily proportional to the actual level of a specific function in a wetland. Therefore, the quantitative scores for wetland impacts and wetland mitigation may not be equal to the functional losses and gains. Additional site-specific data may be required to better determine mitigation requirements for individual sites.

The IVA method evaluates wetland functional indicators for the following three wetland attributes: water quality improvement, wildlife habitat, and social significance. These three attributes can be considered "groupings" of the wetland functions evaluated under the WET method (Table 6.2-2). The method assigns a numerical rank to a broad range of wetland functional indicators as they relate to each of these three wetland attributes. A numerical baseline score is then calculated for each of these three attributes on a scale of 0 to 100. The score for each attribute can then be multiplied by the area of the wetland (in acres) to arrive at the three final "attribute indicator values" for a given wetland.

Table 6.2-2
Relationship Between IVA Wetland Attributes and WET Model Wetland Functions

IVA Wetland Attributes	WET Model Wetland Functions
Water Quality Improvement	Sediment Toxicant Retention Nutrient Transformation
Wildlife Habitat (juvenile foraging fish, shorebirds, wading birds, waterfowl, and passerines are evaluated as separate categories)	General Wildlife General Waterfowl Aquatic Diversity and Abundance General Fish Production Export
Social Significance	Recreation Flood Flow Alteration

The IVA method, like others before it, was developed with the expectation that more quantitative methods would eventually supplant it (Hruby et al. 1995). Limitations of the IVA method are that it is unable to detect potential synergistic relationships among functions, and that it relies upon indices that do not provide an absolute value for each function (Hruby et al. 1995). Moreover, there is no system of verifying the model against a known reference. For example, if the method were used for calculating site-specific mitigation ratios based upon existing functions, projecting the future value of a restored wetland would be subjective without use of a reference, restored wetland for comparison.

The IVA method includes "subattribute scoring" for individual wildlife species groups such as shorebirds, waterfowl, and juvenile fish. The IVA methodology was used by the Meadowlands Interagency Mitigation Advisory Committee (MIMAC) to assess the functions and values of existing wetlands of the Empire Tract (see Section 6.2.2). This interagency team consists of biologists of the representative resource management agencies in the HMD, including the NJMC, USEPA, USACE, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. The IVA analysis conducted by the interagency team was used as a basis for this FEIS.

6.2.2 Regional Setting

In New Jersey, wetlands have been estimated to compose approximately 19% of the state (or 900,000 acres) (Robichaud, Collins and Anderson 1994). In northern New Jersey, several types of wetlands occur, including freshwater marshes, coastal salt marshes, swamps, floodplains, and peatlands (bogs and fens). The general extent of wetlands in the northeastern part of the state, based on data collected by NJDEP, is indicated on Figure 6.2-1. For comparative purposes, the boundary of the HMD and the approximate location of the Empire Tract are shown on the figure.

Figure 6.2-2 shows the extent of existing wetlands in the HMD. NJMC inventories (HMDC 1992) estimate that 8,455 acres of wetlands remain in the HMD. As shown in the figure, the Empire Tract is located on the western portion of a large (approximately 1,070 acre) tract of wetlands in the northern portion of the HMD associated with the Hackensack River.

6.2.2.1 History of Wetlands in the Hackensack Meadowlands

Since the last glacier retreated from New Jersey approximately 17,000 years ago, substantial changes have occurred with regard to wetland habitat, most recently as a result of human settlement. As described in the DEIS for the SAMP (USEPA and USACE 1995): "The melting water [of the glaciers] became trapped behind the moraine to form Glacial Lake Hackensack. Based on analyses of the sediment deposited during this time, the glacial lake existed for at least a period of 2,000 to 3,000 years. Based on recent evidence, the local environment of the

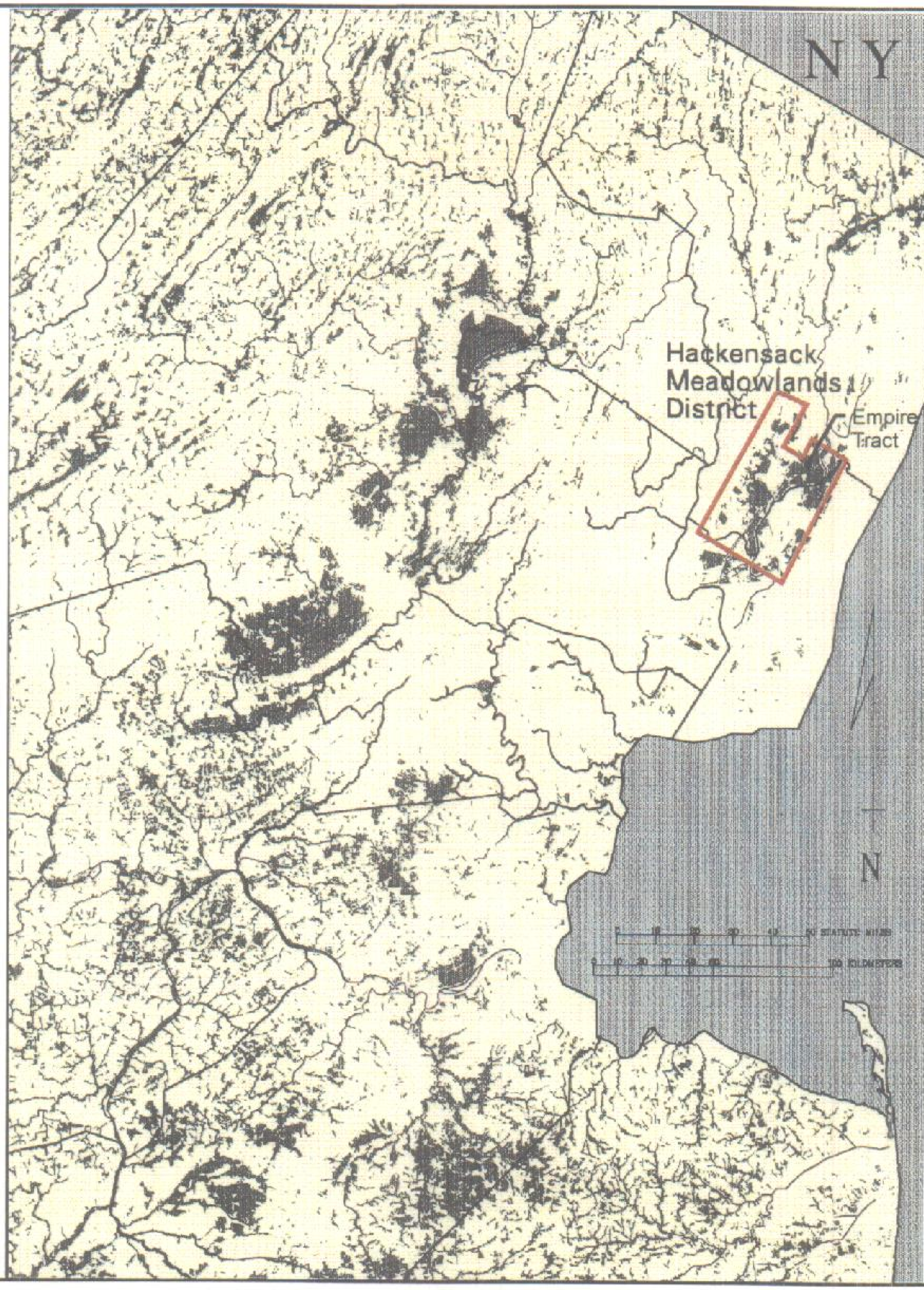
Meadowlands after the moraine was breached and the glacial lake drained (approximately 14,000 years ago) was most likely a well-drained woodland of alder and oak. Wetland environments were probably first formed in the Meadowlands between 2,000 and 3,000 years before the present (BP). As the climate continued to warm, and the glaciers continued to melt, the sea level began to rise. Currently accepted rates of sea level rise for this area are between 1.0 and 1.5 meters (m) per 1,000 years. Thus, between 2,000 and 3,000 years ago, the water elevation in Newark Bay and any tidal reaches of the Hackensack River would have been between 2.0 and 4.5 m (6.5 to 15.0 ft) lower than today. Approximately 2,000 BP, with the rising sea level, many parts of the Meadowlands began to evolve, first into freshwater wetlands, and then into tidal wetlands, vegetated predominantly by salt grass.

About 800 BP, the first Atlantic white cedar (*Chamaecyparis thyoides*) trees appeared in the Meadowlands. The cedar bogs predominated for some three to five centuries, and began to dwindle beginning about 500 years ago. According to late 19th century maps, the then surviving cedar stands were limited to only a few scattered areas, surrounded by common reed (*Phragmites australis*). The apparent island pattern of isolated survival is consistent with ecological models of the takeover of one plant community by another. The pattern of survival also suggests that the former extent of cedar bogs in the Meadowlands was much larger than was found in the late Nineteenth Century.

Recent changes in the Meadowlands have been more abrupt, and more drastic. The first cause of change was the attempt to "reclaim" the Meadowlands as arable land, and beginning in the 1930s, to control mosquito breeding. The diking and ditching undertaken to drain the Meadowlands probably aided in the decline of the cedar bogs. In 1867, the Iron Dike Land Reconstruction Company constructed a dike along the northern bank of the lower Passaic River, around Kearney Point, along the western bank of the Hackensack River, and finally up Sawmill Creek. The section of land that this dike isolated contained a large cedar swamp, which was shown as a "former" cedar swamp on an 1896 map. Because diking prevented the influx of tidal water, and also dried out the marsh, this dike probably contributed to the loss of cedar in the Sawmill Creek area. (However, as stated above, evidence suggests that the cedar swamps started declining approximately 500 years ago, thus some of the reasons for the decline are probably "natural"). Further human factors in the decline of the cedar in the Meadowlands may have been harvesting for use in ship building, to make plank roads to traverse the Meadowlands, and for lumber and shingles; some of the cedar swamps were also burned to drive out pirates.

The second major cause of change in the Meadowlands environment was the construction of the Oradell Dam (completed in 1922). This dam limited freshwater inputs into the Hackensack, and increased the tidal effects, moving the head of tide upstream. As the population served from the

Existing Wetlands of Northern New Jersey

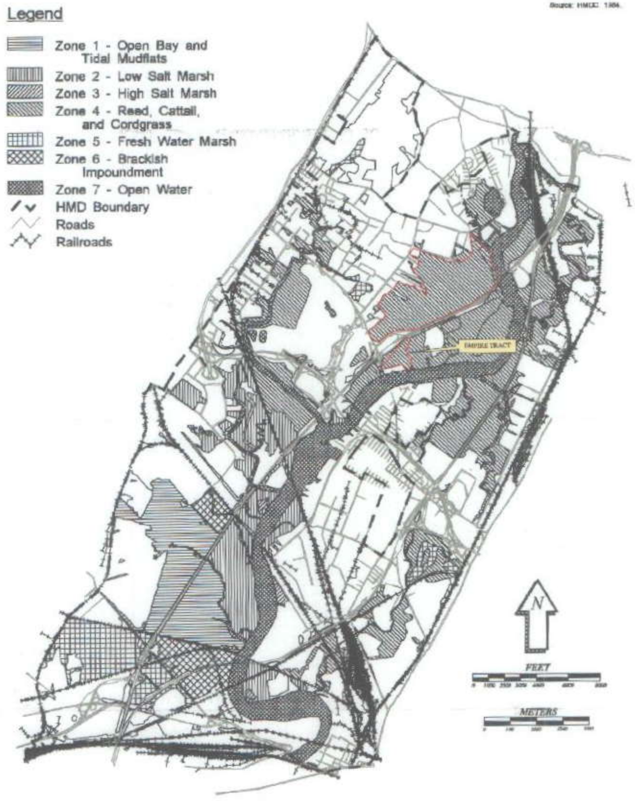


Wetlands

Source: New Jersey Department of Environmental Protection

Figure 6.2-1

Wetland Habitat Types of the Hackensack Meadowlands District



October 22, 1999

Figure 6.2-2

Oradell Reservoir increased, passing freshwater flows decreased, resulting in a more saline environment for most of the District.

A final major historic event also relates to both the dikes that were built to "reclaim" the wetlands and the construction of the Oradell Dam. Because the dikes isolated large expanses of land from tidal waters, the layers of peat that existed at the bottom of the marshes began to dry out, and subside. Common reed began to colonize these drier, less saline areas. A subsidence of three to three and a half feet was reported in the Meadowlands in just 18 years (from 1869 to 1887). Thus, the land behind the dikes sank to lower elevations than the water level in the Hackensack River. In 1950, a major hurricane breached most of the dikes, and the saline waters of the Hackensack River (due to the Oradell Dam) flooded large expanses of the Meadowlands. In some areas (e.g., the Sawmill Creek Wildlife Management Area) the common reed plants were unable to survive in the deeper, more saline water, and large expanses died off. The resulting mud flats are only recently being slowly re-vegetated by salt-marsh cordgrass (*Spartina alterniflora*).

The current major water circulation patterns in the estuary were established in 1922 with the construction of the Oradell Dam. The dam limited the flow of freshwater to the downstream portions of the Hackensack River, and thus increased the upstream encroachment of salt water.

In addition to draining the marshes, some of the estuary was filled to provide land for residential and industrial development. As a result, a total of approximately 8,500 acres of the original wetlands and aquatic habitats in the lower Hackensack River Basin remain in the District today."

Figure 6.2-3 shows historical wetland losses in the New York-New Jersey Harbor estuary region that have occurred as a result of man's activities, primarily the filling of wetlands. As can be seen in the figure, extensive wetland losses have occurred within Essex, Hudson and Bergen counties, including the HMD, particularly during the period from 1966-1989. According to Vermeule (1897), there were 18,580 acres of tidal wetlands and 1,465 acres of freshwater meadows in the Hackensack River basin in 1897. Since approximately 8,500 acres remain today, approximately 58% of the original wetlands in the Hackensack River basin have been filled.

Wetlands and Other Special Aquatic Sites of the Hackensack Meadowlands

As noted above, the "natural" condition for much of the Hackensack Meadowlands is that of a freshwater cedar swamp, but due to extensive changes wrought by man over the past 200 years, this condition is no longer prevalent. In fact, restoration of the natural cedar swamps would be very difficult, in light of several changes that have occurred, such as the construction of the Oradell Dam, which has resulted in increased salinity of the lower portion of the Hackensack

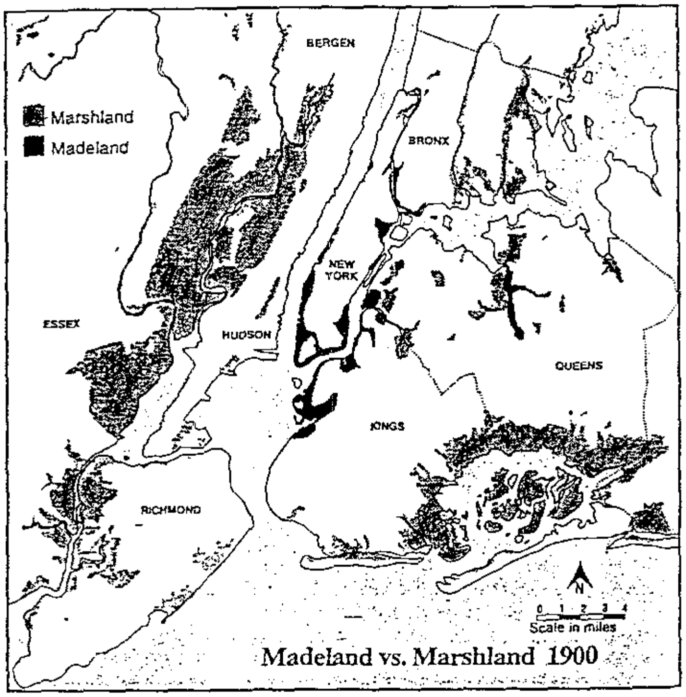
River. Areas now dominated by common reed include areas in which the original peat was drained and became oxidized, and are now several feet lower in elevation than in the 1800s before the swamps were cleared and drained. In addition to being ditched, many of these areas have been diked and tidal flow is now restricted by tidal gates. Restoring inundation to such areas would not promote the growth of cedar, or other freshwater plants. As a result, tidal wetland restoration, mitigation and enhancement programs have favored creation of tidal wetlands that are more closely associated with brackish tidal wetlands that favor species such as smooth cordgrass (*Spartina alterniflora*). These programs have favored brackish tidal wetland enhancement because of its sustainability relative to freshwater enhancement programs, which often become dominated by purple loosestrife (*Lythrum salicaria*) and other exotic invasive species.

Tidal wetland communities occurring in areas such as the lower Hackensack River consist of plant and animals species adapted to different environments corresponding to the range of salinity, degree of tidal inundation, and disturbance (Mitsch and Gosselink 1992). Figure 6.2-4 shows the distribution of these communities across a salinity and tidal water level gradient in a natural tidal marsh setting in New Jersey. While the setting can be best described as a coastal marsh continuum, it describes conditions that prevail in many tidal marsh systems in the Northeastern United States. Figure 6.2-4 provides an example of the coastal marsh zonation as a means of comparing and contrasting site conditions on the Empire Tract. Tidal marshes along the Hackensack River within the vicinity of the Empire Tract do not show this zonation since salinity levels within this reach of the river are lower than that of a typical coastal salt marsh (see Section 6.3).

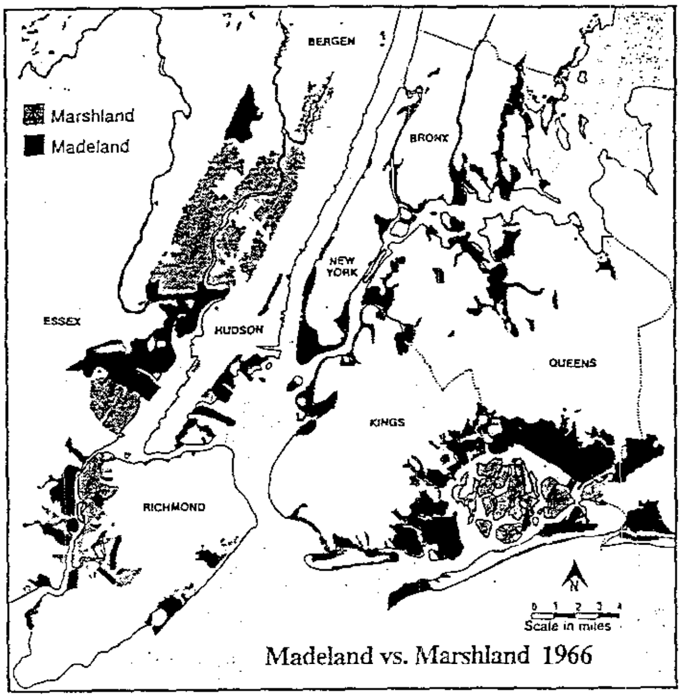
In a traditional model of a coastal salt marsh system, low salt marsh areas are inundated regularly and exhibit higher salinity and greater water depths than areas of higher marsh. Further upslope freshwater conditions prevail, since the ground elevation is above that which is normally influenced by the tide. Moving landward from the marsh, drier upland conditions prevail, and a characteristic upland forest community is present.

Estuarine wetlands within the HMD differ from this model in three respects. Since much of the HMD lies upstream of Newark Bay, it is characterized by lower salinity compared to salt marshes located immediately adjacent to the ocean. The further one travels upriver, the lesser the influence of saline conditions. A second difference is that along the river the hydrology of many wetlands has been altered by ditching, diking, and in some places the placement of berms and tidal gates. This has interrupted the gradual continuum between freshwater and estuarine conditions seen in many coastal marshes. Finally, many of the wetlands in the HMD are not bordered by a vegetative community of upland forest. Rather, development historically

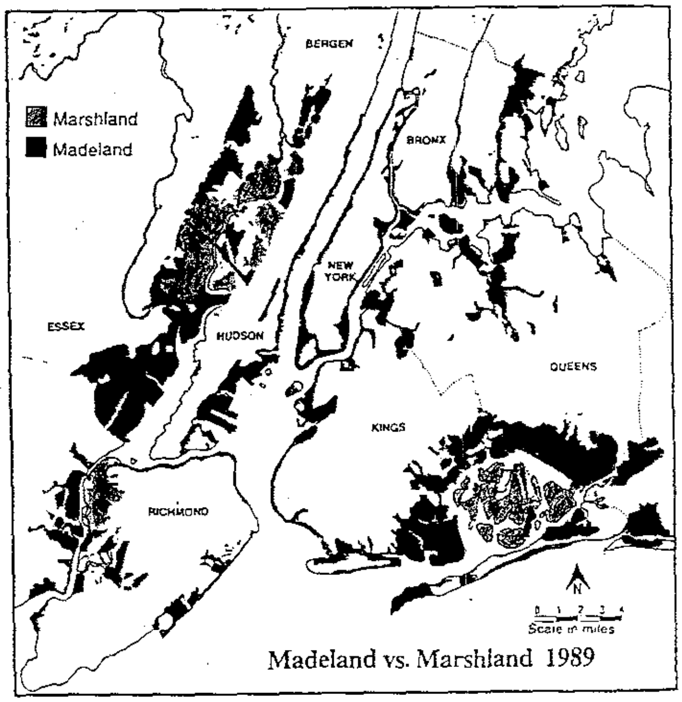
Wetland Filling in the New York-New Jersey Harbor Estuary 1900-1989



Madeland vs. Marshland 1900



Madeland vs. Marshland 1966



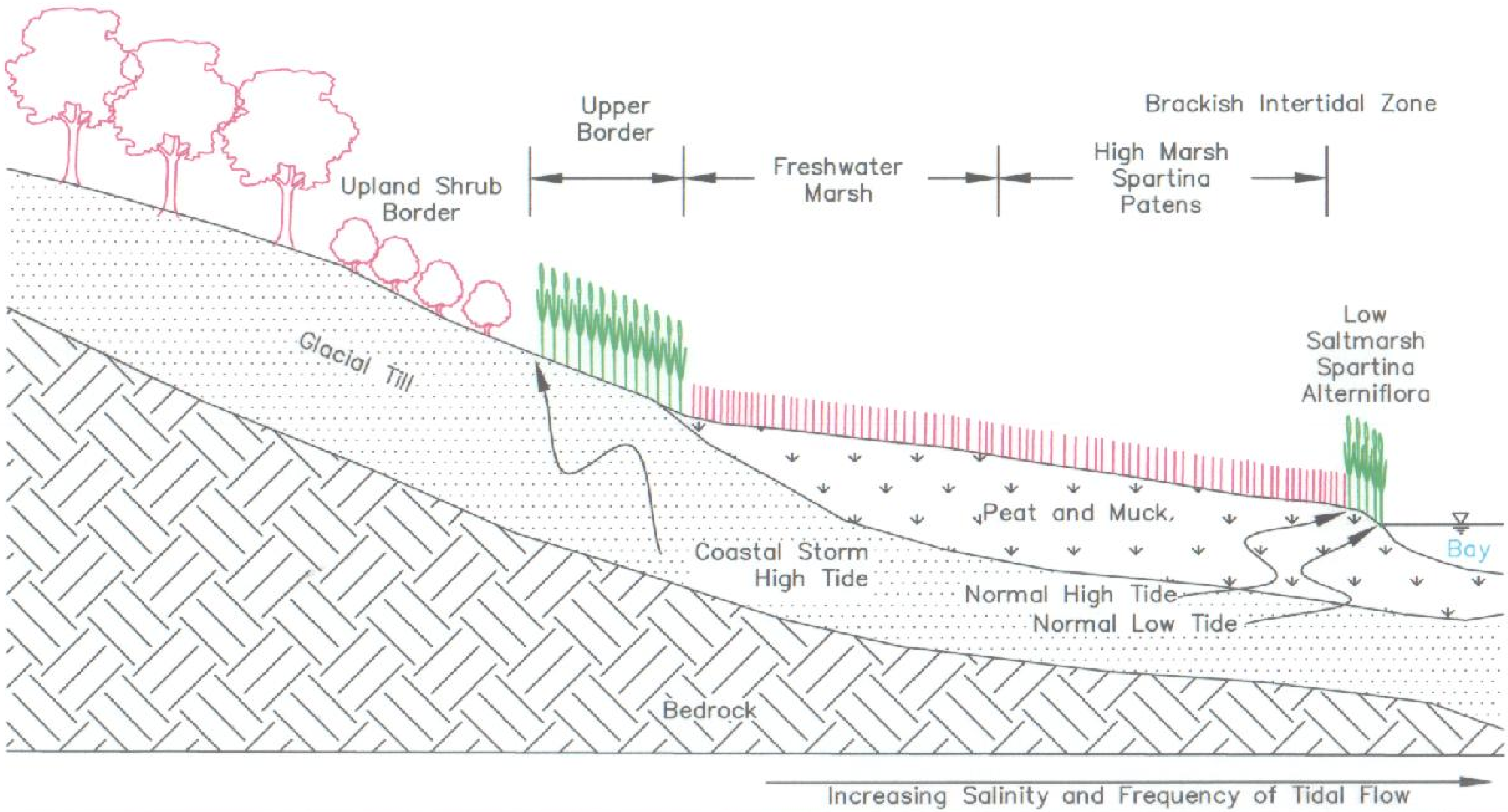
Madeland vs. Marshland 1989

Adapted from: Squires, D.F. 1992. Quantifying anthropogenic shoreline modification of the Hudson River estuary from European contact time to modern time Coastal Management 20:343-354.

Source: U.S. Fish and Wildlife Service 1998

Figure 6.2-3

Characteristic Wetland Communities Associated with an Undisturbed New Jersey Tidal Marsh System



Water Surface

Source: Adapted from Mitsch & Gosselink (1986), Figure 8–6

Figure 6.2-4

encroached to the edge of the wetland, and much of the "upland area" consists of wetlands that have been filled.

Seven wetland and aquatic habitats have been described within the HMD (USEPA and USACE 1995). The extent of these habitats within the HMD is shown in Figure 6.2-2. These habitats are:

- Bay and mud flats - Shallow tidal bays and mud flats of the lower Hackensack River tend to occur mostly in the Sawmill Creek Wildlife Management Area, located approximately 3.5 miles south of the Empire Tract. These habitats are closest to the river's mouth, and have higher salinity values than any other habitats in the HMD. The large expanse of mud flats is of recent origin, forming after a 1950 hurricane. Three types of biota typically utilize mud flat habitat in the HMD: invertebrates that live in the mud, birds and fish that feed on the mud flat invertebrates, and waterfowl that use mud flats for refuge areas.

- Low salt marsh - These areas are dominated by salt marsh cordgrass (*Spartina alterniflora*), and have typical salinity values ranging between 10 to 15 parts per thousand (ppt). The largest area of low salt marsh occurs along the banks of Sawmill Creek. Other areas include portions of Anderson Creek, Lower Berrys Creek, and along the edge of the Hackensack River, in locations such as the NJMC Harmon Meadow Wetlands Mitigation Area. Biota that occur in this habitat include mud snails, crabs, and a variety of rails, bitterns and other water birds.

- High salt marsh - High salt marshes are dominated by salt hay grass (*Spartina patens*) and salt grass (*Distichlis spicata*) and occur adjacent to and at a slightly higher elevation than areas where low salt marshes are found. High salt marshes also contain species tolerant to elevated salinity, such as glassworts (*Salicornia* spp.), some insects, and mummichogs (*Fundulus heteroclitus*). High salt marshes also provide habitat for mice and voles (Teal 1986).

- Common reed - Approximately 62% (5,200 acres) of the HMD wetland and aquatic habitat is common reed habitat. Common reed is an invasive species that dominates wetlands in the northern HMD, and has overgrown nearly all stands of narrow-leaf cattails (*Typha angustifolia*). According to the SAMP DEIS (USEPA and USACE 1995), muskrats (*Ondatra zibethicus*) use common reed plants both for food and as construction materials for their lodges (Dozier 1948), and least bitterns (*Ixobrychus exilis*) and other birds may nest in the common reed.

Common reed is a common perennial grass species which can be invasive and form near-monotypic stands in both estuarine and freshwater environments (Lapin and Randall 1993). While this species is found on both disturbed and pristine sites, various forms of human disturbance, including restriction of tidal inundation within a marsh, can promote its spread (Roman et al. 1984). Common reed invasions can reduce the wildlife habitat value of tidal marshes by altering the structure and function of relatively diverse marshes dominated by saltmarsh cordgrass and other species (Roman et al. 1984).

- Freshwater marsh - Freshwater marshes in the HMD are generally wetlands that are not connected to tidal waters, and which are influenced by freshwater from upland runoff or groundwater. Freshwater marshes of various sizes are found in Kearny Marsh, the Penhorn Creek basin, North Bergen, Losen Slote Creek, areas near Teterboro, and in small pockets throughout the lower Hackensack River floodplain. Although freshwater marshes in the HMD often contain grasses, such as panic grass (*Panicum virgatum*) and bluestem grass (*Andropogon virginicum*), most HMD freshwater marshes are now dominated by common reed. In addition, forested wetland areas occur near Teterboro Airport, Losen Slote Creek, and around Snake Hill.

  Several species of animals use freshwater marshes in the HMD, including the snapping turtle (*Chelydra serpentina*), spotted turtle (*Clemmys guttata*), eastern painted turtle (*Chrysemys p. picta*), and the southern leopard frog (*Rana sphenocephala*). In addition, breeding birds observed in the HMD include red-winged blackbirds (*Agelaius phoeniceus*), marsh wrens (*Cistothorus palustris*), and green herons (*Butorides striatus*).

- Brackish impoundment - The diking and ditching that occurred in the HMD to create the freshwater marshes also created brackish impoundments. These are areas where dikes have been breached or leak, allowing an inflow of salt water. The brackish impoundments are important habitats for birds, such as wading birds and shorebirds, due to their productivity.

- Open water - Open waters of the Hackensack River and its tributaries can be considered separate habitats from those found in shallow water wetlands. As these areas are permanently inundated, they are inhabited by many species of fish. The aquatic regions of the District are tightly linked with the wetlands in the coastal ecosystem by providing the mechanism for transporting water (and thus nutrients, organic matter, toxics, and wildlife species) into and/or out of the wetlands (USEPA and USACE 1995).

Of the above habitats, common reed habitat is clearly the most extensive in the HMD (USEPA and USACE 1995). Only 750 acres (9%) of the wetlands in the HMD that are vegetated are not dominated by this species (NJMC 1992).

6.2.2.2 Wetland Functions and Values of the Hackensack Meadowlands

Existing wetland functions and values within the HMD were originally assessed by an interagency team (USEPA, USACE, NJDEP and NJMC) to identify potential environmental impacts associated with implementation of the then-proposed SAMP for the HMD (USEPA and USACE 1995). The purpose of the assessment was to rank different wetland assessment areas in the HMD to determine which areas might be most appropriate for enhancement, restoration, preservation, and development (Figure 6.2-5). The functional assessment initially evaluated 92% of the wetlands in the HMD using the WET method.

The results of the functional assessment indicated that:

- Most of the HMD wetlands have a high probability for performing sediment stabilization, sediment/toxicant retention, nutrient removal/transformation, and providing fish habitat and waterfowl habitat functions.
- Most of the HMD wetlands are highly likely to have the opportunity to perform sediment/toxicant retention and nutrient removal/transformation functions.
- Large wetlands within the HMD also have a high probability of performing aquatic diversity/abundance and general wildlife habitat functions.
- As a whole, the District wetlands have a low probability in their effectiveness for performing groundwater or flood flow alteration functions, since most are tidal wetlands that are subject to regular inundation, and hence have low capacity for flood flow storage (USEPA and USACE 1995).

Results of the functional assessment originally presented in the SAMP DEIS also indicated that the wetlands that received the highest ratings for "multiple functions" corresponded to those areas already considered by NJMC to be of high value and significance in the Meadowlands. These areas include the Sawmill Creek Wildlife Management Area; the intertidal mud flats to the west of Sawmill Creek; Kearny Marsh; the brackish impoundments to the east of Kearny Marsh; the forested wetlands and wet meadows in the vicinity of Teterboro Airport and Losen Slote Creek; the lower reaches of Berrys Creek; and the Hackensack River. The results of the functional assessment also showed that all wetland assessment areas within the HMD are likely to perform at least one or two wetland functions, while none of these wetlands are likely to perform all of the functions evaluated.

Results of the assessment were used to identify the extent of any wetlands in the HMD that could be filled with minimal environmental impacts relative to other, more valuable wetlands (USEPA and USACE 1995). The assessment indicated that of the 7,820 acres of wetlands assessed using the WET method, 129 acres met at least one of the two criteria for "potential future disposal sites" for fill material, while 6,710 acres met at least one of the criteria for "areas generally unsuitable for designation as a disposal site" for fill material (USEPA and USACE 1995). The remaining 981 acres were considered "indeterminate", meaning the wetlands had attributes of both "suitable" and "unsuitable" categories (USEPA and USACE 1995).

Subsequently, wetland assessment areas in the HMD were ranked by an Interagency team using the IVA method, from the perspective of water quality improvement, wildlife habitat, and social significance. Figures 6.2-6 through 6.2-8 show the distribution of these scores in different assessment areas in the HMD.

6.2.3 Empire Tract

6.2.3.1 Overview

The 587-acre Empire Tract consists of approximately 542 acres of wetlands, and 27 acres of shallow open water, that includes 11 acres of mud flats and 2 acres of vegetated shallows. The remaining 18 acres consist of small upland areas scattered throughout the site and along its perimeter (Table 6.2-3). Most of these upland areas consist of former wetlands that were historically filled. There are no sanctuaries, refuges, coral reefs, or riffle and pool complexes that occur on or adjacent to the site. The property contains approximately 6.7% of the wetlands in the HMD, and is located in the western portion of a larger, approximately 1,070-acre area of wetlands associated with the Hackensack River.

Wetland Assessment Areas in the Hackensack Meadowlands District

Source: USEPA, Functional Assessment Report, 1990.

Figure 6.2-5

Water Quality Improvement of Wetlands in the Hackensack Meadowlands District - Normalized Scores

- IVA Assessment Area, Water Quality Improvement Normalized Attribute Score
- Wetlands Not Evaluated
- HMDC Boundary
- Roads
- Surface Water
- Railroads
- Empire Tract Boundary

FEET: 0 1000 2000 3000 4000 6000 8000

METERS: 0 500 1000 1500 2000

N

Source: Hackensack Meadowlands SAMP/EIS, USEPA and USACE 1995.

Figure 6.2-6

Hackensack Meadowlands District Wildlife Habitat - Normalized Scores

Source: Hackensack Meadowlands SAMP/EIS, USEPA and USACE 1995.

Figure 6.2-7

Hackensack Meadowlands District Social Significance - Normalized Scores

Source: Hackensack Meadowlands SAMP/EIS, USEPA and USACE 1995.

Figure 6.2-8

Table 6.2-3
Summary of Wetlands Habitat Acreage Under the Existing Conditions

Habitat Category	*Existing Conditions /No-Action Alternative*
Uplands	
Dikes, Roadways, Vegetated Areas	*18*
Mixed-Use Development	*0*
Upland Islands within the Wetland	*0*
Subtotal	*18*
Wetlands	
Non-Tidal Freshwater	
Forested	*0*
Scrub-Shrub	*0*
Wet Meadow	*0*
Common Reed	*532*
Tidal Brackish	*10*
Storm Water Detention for Development	
Wetland Subtotal	*542*
Shallow Water	
Non-Tidal Freshwater	
Vegetated Shallow	*2*
Mud Flat	*6*
Unvegetated Bottom	*7*
Subtotal	*15*
Tidal/Brackish	
Vegetated Shallow	*0*
Mud Flat	*5*
Unvegetated Bottom	*7*
Subtotals	*12*
Shallow Water Subtotal	*27*
TOTAL	*587*

6.2.3.2 Wetland Communities and Other Special Aquatic Sites on the Empire Tract

The majority of wetlands on the Empire Tract, located landward of the tidal gates and berms (542 acres), like wetlands elsewhere in the HMD, are dominated by common reed. The common reed wetlands covering most of the Empire Tract (on the landward side of the berm) have a hydrology governed primarily by freshwater inputs. Salinity is variable and changes seasonally with the amount of precipitation entering the watershed. Salinity is also influenced by the lateral intrusion of Hackensack River water onto the site when the tide gates leak under certain conditions. During severe storm events (e.g., a 10-year storm) the river water may also overtop the dikes. Groundwater salinity within these wetlands may be influenced by the interaction between surface water and groundwater, or residual salt in the marsh soils from occasional inundation events coupled with evaporation. Salinity levels could also be affected by brackish water entering the site through the leaking tide gates, and moving laterally from the creeks into the adjacent wetlands.

Conductivity data (which may be used as an indirect measure of salinity) collected from shallow wells in 1998 and 1999 showed that the shallow groundwater in the portion of the site closer to the Hackensack River has higher conductivity than that located further away (PS&S 2000b). This indicates some interchange exists between surface water and groundwater within the immediate vicinity of the river (see Section 6.3). The two wells located closest to the river, W-1 and W-5, exhibited the highest and third highest conductivity values (PS&S 2000b). A more inland well, W-2, had the second highest conductivity values.

Occasionally, salinity values as high as 8 ppt have been recorded in portions of the wetlands and creeks on the Empire Tract, levels that are indicative of brackish conditions. The USFWS has mapped the wetlands on the Empire Tract as "estuarine emergent". According to the USFWS (Cowardin et al. 1979), coastal marshes that have ocean-derived salts measuring greater than 0.5 ppt during the period of average annual low flow, and that have open, partially obstructed or sporadic access to the open ocean through tidal action, are considered estuarine wetlands. The USFWS would classify such wetlands as estuarine regardless of whether or not tidal flow were restricted by tidal gates or berms (R. Tiner and USFWS 1998, personal communication). Other portions of wetlands and creeks on the Empire Tract have salinity values below 0.5 ppt, and would be classified as palustrine (non-tidal freshwater) wetlands under the same classification.

The distribution of different wetland habitat types on the Empire Tract is shown in Figure 6.2-9. The figure shows the salinity line delineating between freshwater and brackish conditions as determined by instantaneous salinity measurements made during June and July 1991 (URS Greiner 1992). It should be noted that this line represents a "snapshot" in time of the extent of brackish conditions on the Empire Tract, and actual conditions probably vary seasonally, if not more frequently.

Freshwater Marsh (Common Reed)

Of the 542 acres of wetlands on the Empire Tract, approximately 94% are dominated by common reed (TAMS 1998). Most of these wetlands are characterized by palustrine, or freshwater conditions.

The remainder of the freshwater wetland habitats on site are generally limited to areas of 3 acres or less. These areas were mapped during field studies of site vegetation communities conducted in 1997 (TAMS 1998a), and include:

Wetlands of the Empire Tract

Freshwater Marsh
- Common Reed
- Marsh Fern and Common Reed
- Panic Grass and Common Reed
- Broomsedge and Common Reed

Low Tidal Marsh
- Cordgrass
- Spikerush
- Bluejoint Grass and Common Reed

Brackish Marsh
- Common Reed

Open Water and Mudflats
- Open Water and Mudflats
- Salinity Line

Other
- Successional
- Property Boundary

Approximate location of Freshwater Line (salinity 0.5 ppt). Line is based upon data gathered from on-site water sampling (June and July, 1991).

Figure 6.2-9

- A mixed common reed and marsh shield fern (*Thelypteris palustris*) community in the vicinity of Moonachie Creek (about 3 acres).
- A mixed common reed and bluejoint grass (*Calamagrostis canadensis*) community near the Transco inspection road (about 8 acres).
- A mixed common reed and broom sedge (*Andropogon virginicus*) community near Moonachie Creek (about 3 acres).

Low Salt Marsh (Tidal Spikerush and Smooth Cordgrass)

Dwarf spikerush (*Eleocharis parvula*) and smooth cordgrass (*Spartina alterniflora*) vegetative inclusions occur along tidal flats outside of the berm system adjacent to the Hackensack River (less than 3 acres).

Open Water

Open water areas account for approximately 16 acres of the Empire Tract. These areas consist of the creeks that cross the site, and the Hackensack River itself adjacent to the site (although this was not included in computing the site acreage). Open water areas supporting rooted aquatic vegetation under normal circumstances are referred to as vegetated shallows (40 CFR §230.43). Vegetated shallows were noted in the on-site creeks at two locations: one in Bashes Creek and the other in Muddabach Creek (TAMS 1997). The dominant submerged aquatic vegetation at both locations was water-milfoil (*Myriophyllum humile*). Together these areas comprise approximately 2 acres. In addition, 14 acres of open water with unvegetated bottom occur on the Empire Tract.

Mud flats

In coastal areas, mud flats are broad flat areas that are exposed at extremely low tides and inundated at high tides, with the water table at or near the surface of the substrate (40 CFR §230.42). They are either unvegetated, or vegetated only by algal mats. Throughout much of the year, most of the creek bottoms on the Empire Tract typically are covered by less than one foot of water, and the unvegetated sides and the inside bends of the creeks are often exposed. In addition, there are narrow bands (generally less than 30 feet wide and outside of the berms along the Hackensack River) of mud flats exposed during low tide on both parcels. An estimated 11 acres of mud flats are present on the Empire Tract.

6.2.3.3 Wetland Hydrology of the Empire Tract

An understanding of the hydrology of the wetlands of the Empire Tract is important not only because of its importance in determining what wetland communities are present, but also in assessing what values and functions the wetlands provide. Wetland communities on the Empire Tract differ from tidal salt marsh communities that are regularly inundated and occur along an environmental gradient of increasing salinity and tidal flow. In contrast to the typical condition shown in Figure 6.2-4, wetlands on the Empire Tract are generally not influenced by daily tidal inundation. They are influenced, however, by periodically leaking tide gates that allow river water to flow into site creeks. As shown schematically in Figure 6.2-10, normal tidal surface water flows from the Hackensack River onto the Empire Tract are largely restricted by dikes and tide gates, which influences both salinity and the water elevation of the marshes on the Empire Tract. The marshes are fed primarily by precipitation and to a lesser extent by freshwater surface and groundwater flows from runoff entering the creeks on site from developed areas upgradient in the watershed. The marshes also receive groundwater flow from upgradient areas within the watershed, and shallow wetland groundwater near the creeks may receive surface water from site creeks moving laterally through the peat when conditions exist for such flows to occur.

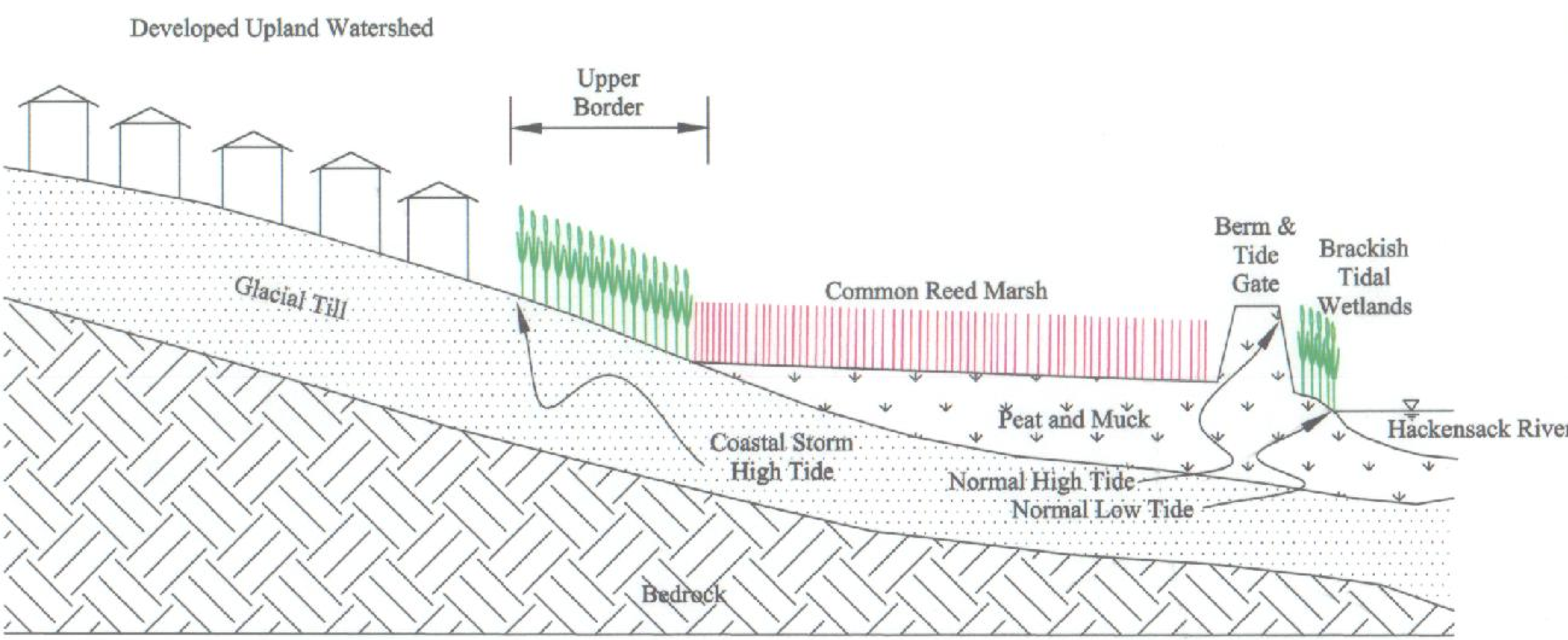
Approximately 22 acres of the Empire Tract are tidally inundated under normal circumstances. A large embankment along the New Jersey Turnpike, and tidal gates and berms located at the terminus of Moonachie, and Muddabach creeks and Losen Slote, effectively prevent tidal flow from entering the majority of the site under normal circumstances. The effect of the berm and the gates on the wetland community, as well as historical ditching, is shown generically in Figure 6.2-10. The tidally inundated portions of the Empire Tract are limited to 5 acres of mud flats, 7 acres of open water, and approximately 10 acres of wetlands along the Hackensack River located on the Hackensack River side of the embankment (Figure 6.2-9).

Most of the wetlands on the Empire Tract are not subject to regular surface water or tidal inundation. As a result, wetlands on the Empire Tract receive considerably less water than areas at comparable elevations (0-2 ft NGVD) in the HMD (TAMS 1998). The water entering the wetlands on site consists of precipitation, with limited runoff from adjacent higher elevation areas, including flows entering the site via storm sewers, flows from Moonachie Creek, overland flows, and groundwater flows. It also includes some input from leaking tide gates along the Hackensack River.

Figure 6.1-6 provides a conceptual model of the hydrology of the Empire Tract wetlands. This model represents a water budget for the site based upon the following information collected:

- Storm water modeling of the site watershed, as well as the creeks on site;
- A sensitivity analysis of the storm water modeling to determine its relative accuracy;

Wetland Communities in Tidally Restricted Portions of the Hackensack River Ecosystem



∇ Water Surface

Source: Adapted from URS Greiner (1997)

Figure 6.2-10

- Weekly precipitation data collected from nearby Teterboro Airport over the past 12 years;
- Geotechnical borings collected on the Empire Tract that describe the underlying substrate and its permeability;
- Creek surface water and wetland groundwater elevation data collected on the Empire Tract during 1998 and 1999, and again in the fall of 2000, using additional wells installed at the request of USACE;
- Topographic data collected on and adjacent to the Empire Tract;
- Location and size of existing tide gates affecting flows on the Empire Tract;
- Staff gauge data collected periodically over a one year period from storm water outfalls entering the Empire Tract in relation to precipitation events and calibration to the model;
- Permeability data of the soil collected within and adjacent to site creeks; and
- Historical observations of the duration and extent of flooding on the Empire Tract and surrounding area.

Most of the water entering the Empire Tract is in the form of channel flow entering from storm water outfalls located on the western, developed edge of the site (USEPA 1989, PS&S 2000b). This conclusion is based on studies conducted by the applicant at the request of USACE, observations of the site made by agency personnel during the AVID study and field visits by USACE to investigate hydrological issues. Channel flow originates from runoff generated by precipitation and the largely impervious cover within the communities of Moonachie and Carlstadt (see Section 6.13 for discussion of the watershed, and a watershed map). This water enters into the creeks that cut through the site, and eventually discharges through the tidal gates near the Hackensack River. Velocity measurements recorded by the applicant indicate that under most conditions the water in the creeks is nearly stagnant, but during storm events this water may leave through the gates more quickly, or it could flood the site, depending upon the tidal stage within the Hackensack River (PS&S 2000b). If the tidal stage is very high, either during a high tide or low tide event, the tide gates will not allow water to leave the creeks, and some overbank flow may occur. This is thought to occur rarely. Most of the time the surface water entering the site flows within the banks of the creeks and is in contact with the wetlands immediately adjacent to the creeks.

The major source of water for the wetlands is precipitation falling directly onto the site (PS&S 2000a, PS&S 2000b). Precipitation is known to be a major component of flow to the wetlands of the Empire Tract, since groundwater levels in wells monitored on site responded rapidly to precipitation events. Due to the relatively level topography on the site compared to the surrounding watershed, and the fact that the site wetlands are underlain by a peat layer and clay layer, precipitation tends to saturate the wetland and stay in place. Some of this precipitation may eventually drain into the creeks on site, depending upon conditions. During summer months, much of this precipitation is likely taken up by the common reed present on the site. These plants may transpire as much as 1.5 meters of water in a year (Haslem 1970) with the majority of the transpiration occurring in the summer months. This is likely a major reason why groundwater levels monitored on the Empire Tract were up to 4 feet below the ground surface during summer months. During fall, winter, and spring months, precipitation recharges shallow ground water and runoff from the wetland into the creeks is more likely, as the water is not absorbed by the plants. Recharge into the groundwater is likely to be minimal, given the relatively impervious nature of the compressed peat (meadow mat) below the site, and the underlying varved silt and a clay layer that inhibits infiltration of water.

Some shallow groundwater flow from upgradient areas to the north and west of the site may enter the wetlands of the Empire Tract. However, the wetland is larger than its surrounding watershed, and most of the watershed is covered by impervious cover. In addition, the same geologic layers that inhibit the downward movement of surface water into groundwater in the wetland also serve to inhibit the upward discharge of deeper groundwater into the wetland. In general there is little vertical interaction between the deep regional groundwater flow and the shallow groundwater system beneath the wetlands within the HMD (see Section 6.13). These conditions suggest that groundwater flows are less of a contributing factor to the wetland hydrology of the site than surface water via channel flow, and direct precipitation.

The surface water in the creeks on site is clearly influenced by the Hackensack River under conditions that allow the tide gates to leak. This apparently occurs fairly regularly, as evidenced by raised salinity and conductivity levels reported in these creeks. Overbank flow from the Hackensack River appears to be a rare event associated with severe storms. Storm water modeling data (see Section 6.13) indicates that a 10-year flood of the Hackensack River would be required for the river to reach a sufficient elevation to overflow the berm between the Empire Tract and the river. Periods of inundation on the Empire Tract are more likely to occur as a result of elevated river elevations during tidal events coupled with heavy precipitation that prevent tide gates from opening and allowing water from the creeks to leave the site. During these events, portions of the site may flood. The extent to which the site may flood under different scenarios is discussed further in Section 6.13.

The influence of the Hackensack River on groundwater was also investigated. Data collected from March 1998 to October 1999 indicate that shallow groundwater in observation wells located inland of the river on the Empire Tract was not significantly influenced by tidal flow. Shallow groundwater levels in observation wells located close to the Hackensack River (within 200 to 300 ft) showed some minor tidal fluctuation, indicating a tidal influence in areas closer to the river. Conductivity data collected from these observation wells also indicated a tidal, saline influence closer to the river (see Section 6.13).

The water budget developed for the Empire Tract indicates that overall most of the hydrology of the site wetlands is provided by direct precipitation, and to some extent channel flow from the creeks on site (PS&S 2000a). Channel flow may enter the wetlands during episodes of overbank flooding associated with major storm events coupled with very high tides or tides that do not allow the tide gates to evacuate water from the creeks into the Hackensack River. The applicant observed this during a two-to three-week period in 1998. Water from the creeks may also enter the wetlands adjacent to the creeks laterally in summer months, when evapotranspiration from the common reed plants decreases groundwater levels. During these periods there may be a sufficient landward flow gradient for water to move from the creeks into the wetlands for a distance governed primarily by the hydraulic gradient (the difference in water level elevations between the groundwater and surface water) (PS&S 2001a). Studies completed after publication of the DEIS investigated the permeability of creek bed and banks as a factor influencing lateral movement of water from creeks into adjacent wetlands. The results indicated that the sediments at the bottom of the creeks provide low permeability, thereby limiting water movement. The side banks, however, consist primarily of peat, which has high permeability rates that allow for lateral movement of water providing a sufficient hydraulic gradient exists. The overall water budget model has important implications regarding the potential water quality treatment functions of the Empire Tract wetlands, as further discussed in Section 6.2.3.5.

6.2.3.4 IVA Assessment of the Empire Tract

The wetland functions and values on the Empire Tract were evaluated as part of a broader evaluation of wetland values in the HMD originally conducted for the SAMP DEIS, using the IVA methodology. The Empire Tract was included in six separate assessment areas. These were areas 2E, 2F, 2G, 2H, 2N and 2T (Figure 6.2-5). Results of the assessment indicated that wetlands on the Empire Tract have a comparable value for water quality and wildlife habitat relative to other wetlands in the HMD (Figures 6.2-6 and 6.2-7), and a low value for flood retention (Figure 6.2-8).

In interpreting the results, one must consider that the IVA attribute values representing the baseline scores for each assessment area (2E, 2F, 2G, 2H, 2N and 2T) are "normalized" by dividing by the highest value scored for that attribute at any site evaluated in the HMD. These values are shown in Figures 6.2-6, 6.2-7 and 6.2-8. They are then multiplied by the corresponding acreage of each assessment area to arrive at the resultant value. A larger site size can thus offset a lower attribute value and vice versa.

The IVA analysis conducted by the interagency team for the SAMP DEIS was updated in May 2000 to reflect additional information collected on site-specific conditions at the Empire Tract. Results are presented in Table 6.2-4. The wildlife component has been subdivided into different categories reflecting different species groups using wetlands in the HMD. These scores provide a baseline against which to compare predicted wetland functions on the Empire Tract, in the future, under different development alternatives. Further details on how the site was scored are provided in Appendix A. Since analyses of other assessment areas in the HMD also could be updated, the original numbers from the SAMP DEIS were used as a broad scale comparison in the figures presented in this FEIS, to provide the reader with a general comparison to other areas within the HMD.

Table 6.2-4
Normalized IVA Scores for Wetland Functions on the Empire Tract

Assessment Area	Acreage	IVA Value						
		Water Quality Improvement	Wildlife					Social Significance
			Juvenile Fish	Wading Birds	Shorebirds	Waterfowl	Passerine Birds	
2E	454	64	11	56	54	55	56	24
2F	5	51	10	40	40	43	41	4
2G	44	52	7	46	44	47	47	4
2H	20	33	29	56	53	65	49	12
2N	15	45	7	59	48	43	59	24
2T	42	45	6	43	41	46	46	14
Total	580							

Note: Acreages of assessment areas identified by USEPA (1989) add up to 580 acres, as opposed to the actual 587-acre site. The assessment area defined on the 1989 study did not include 7 acres of uplands.

The following is a qualitative evaluation of specific wetland functions of the Empire Tract that are addressed by the IVA methodology. Because of the limitations of functional assessment models such as the IVA, site-specific data were incorporated into the discussion below. Site-specific data used include results of storm water modeling and tidal modeling, hydrological data collected on the Empire Tract, water quality data for site water bodies and the adjacent Hackensack River, soil borings, topographic surveys, fish and wildlife surveys, and other site-specific data including water quality for wetlands, permeability of creek banks, creek beds and wetland substrate.

6.2.3.5 Assessment of Empire Tract Wetland Functions and Values

The three major categories of wetland values in the Hackensack Meadowlands as measured by the IVA method are water quality improvement, wildlife habitat and social significance. Water quality improvement is a result of wetland functions such as sedimentation and transformation that filter out nutrients and toxic compounds from the water column, and break them down into less harmful substances. Wildlife habitat refers to the ability of a wetland to support different kinds of wildlife, as well as overall wildlife abundance. Social significance includes the values that wetlands provide regarding storage of flows that might normally cause flooding, as well as recreational opportunities.

The wetland functions that account for these values differ between wetlands having different characteristics. The following discussion provides an overview of the characteristics affecting each of the wetland functions considered in this FEIS, followed by a discussion of the specific functions provided by wetlands on the Empire Tract.

6.2.3.5.1 Water Quality Improvement Functions

Wetlands are usually located at lower elevations in the landscape, and thus may act as settling basins for sediment particles that are carried in overland runoff. Phosphates, pesticides, and heavy metals attached to these particles may settle out. Additional sediment may then settle over the previously deposited sediment, in effect burying it and making these substances unavailable to water bodies where they might cause harm. Wetland soils are often rich in organic matter, which can bind organic chemicals such as pesticides and other harmful substances. In addition, anaerobic bacteria and other microorganisms can act to break down or transform these chemicals into compounds that are less harmful to the ecosystem. These processes are collectively referred to as water quality improvement functions. In essence, wetlands act to filter out sediment, nutrients and toxic chemicals before they enter streams, rivers and other water bodies. Because they differ with respect to their hydrology (water source), vegetation, geological history, and position on the landscape, wetlands may differ with respect to the amount of water quality improvement functions they provide.

Wetland functions important for water quality improvements include nutrient removal and transformation, as well as sediment toxicant retention (Adamus and Stockwell 1983). The ability of a wetland to improve water quality is influenced by its ability to retain toxic particles and nutrients via sedimentation, or settling out of suspended particles, as well as its ability to transform or break down nutrients and other toxic substances into less harmful forms via vegetative uptake and microbial breakdown. These functions were assessed on the Empire Tract using the IVA method.

According to the IVA results calculated by the MIMAC team in May 2000, the IVA gave a score of 53 out of 100 for water quality for assessment area 2E, which covers most of the Empire Tract. This score indicates an average function when compared to other wetlands in the HMD. The revised baseline score calculated by the MIMAC indicated a similar score of 64 for water quality improvement function.

One important limitation of existing wetland functional assessment models such as the IVA method is that significant progress has yet to be made in evaluating biogeochemical functions of different types of wetlands (Trettin et al. 1994) and understanding how they may change over environmental gradients (Brinson 1993). Thus, it is difficult to predict the potential water quality improvement function of a wetland based on functional assessment models alone. Because of this, site-specific hydrological and water quality studies have been conducted to measure the potential for wetlands on the Empire Tract to improve water quality (PS&S 2000a and 2000b). Results of these studies indicate that the water quality improvement function of the Empire Tract wetlands is limited by historical alterations to the hydrology of the wetlands on the site.

Specific wetland functions are described below for all wetlands, followed by a qualitative discussion of the likelihood of Empire Tract wetlands to perform these functions based upon the studies completed on the site.

Overview of Nutrient Removal and Transformation Functions

The nutrient removal transformation function refers to the ability of a wetland to retain or transform inorganic materials, such as nitrates or phosphates, from runoff or groundwater. According to Brinson et al. (1995), nutrient cycling in floodplain wetlands is determined to be influenced by annual productivity and decomposition. Removal of imported elements and compounds is determined by surface and subsurface inflows, overbank flow (in riverine or stream systems), microtopographic complexity, surfaces for microbial activity, and sorptive properties of soils.

Nutrient dynamics in estuarine marshes are complex. Wetlands often act as nutrient sinks, but estuarine marshes have been shown at times to be both sources and sinks of nutrients (Mitsch and Gosselink 1993). These differences may be seasonal or site-specific and are still not fully understood (Mitsch and Gosselink 1993). Much of what is known of the influence of wetland functions on water quality improvement (e.g., removal or sequestering of nutrients and metals) comes from the literature on constructed wetlands. These studies have shown that different nutrients (e.g., nitrogen and phosphorus) cycle through wetland systems in different ways.

Studies of nitrogen flow through wetlands indicate that the primary removal mechanism is via denitrification (Bowmer 1987, Moraghan 1993, Dorge 1994, Davidsson and Leonardson 1996, Groffman and Hanson 1997, Hao and Martinez 1998, Ingersoll and Baker 1998) and plant uptake (Ingersoll and Baker 1998). Prior studies also have shown denitrification to be influenced by the degree of saturation or inundation (Groffman and Hanson 1997) as well as organic matter present. However, concentrations of nitrate in influent water entering the wetland was shown to be more important than organic matter in determining denitrification rates in a freshwater system (Davidsson and Leonardson 1996).

In contrast, the mechanism for phosphorus removal appears to be sedimentation, as most phosphorus entering artificial wetlands appeared to remain in the sediment (Mitsch et al. 1995, Moustafa et al. 1996). In most wetlands designed for wastewater treatment, retention time is a critical design parameter since it allows settling of solids (Kadlec and Knight 1996).

The ability of tidal common reed wetlands to improve water quality, as well as their ability to export carbon into the adjacent estuary as an energy source for the aquatic food chain, has been documented in the literature. Common reed has been used extensively in Europe for water quality improvement in designed (non-tidal, freshwater) systems (Tanner 1995). While a significant knowledge base exists concerning the functional attributes of wetlands constructed for water quality treatment (reviewed in Philips et al. 1993; Kadlec and Knight 1996), as well as natural processes occurring within estuarine systems (Mitsch and Gosselink 1993), evaluation of biogeochemical functions in natural common reed marshes has been largely unaddressed.

Nutrient Removal and Transformation Functions of Empire Tract Wetlands

Based upon hydrological studies conducted on the Empire Tract, it is apparent that the common reed wetlands receive flows primarily from precipitation, some shallow groundwater flows from upgradient areas, and surface water flows from the creeks on-site during periods of flooding or when creeks may recharge shallow groundwater levels during late summer months. Site-specific studies completed indicate that the wetlands on the site are not often or regularly inundated. This is because the presence of tidal gates and berms largely restrict tidal flows, and flooding is mostly limited to overbank flow from creeks during occasional periods when the tidal stage in the Hackensack River does not allow storm water to leave the site. As a result, the overall potential for the Empire Tract wetlands to provide water quality improvement *via sedimentation* appears to be low, and limited to occasional periods of the year when portions of the site are flooded.

The wetlands on the Empire Tract provide a source of water quality improvement to shallow groundwater at the surface of the peat (meadow mat) layer during periods when water can move laterally from site creeks through the adjacent peat layer (PS&S 2001a). While the meadow mat generally acts as a confining layer to downward movement of water, certain kinds of peat, such as that associated with common reed, have moderate horizontal hydraulic conductivity. Permeability measurements taken on the Empire Tract indicate that the peat along the sides of the creeks does not significantly limit lateral flow. Surface water from these creeks will move laterally through the creek bank into wetland groundwater during periods of the year when these creeks are "losing" streams; that is, when they act to recharge shallow groundwater in portions of the site influenced by the creeks.

Interaction between surface water and shallow groundwater may also occur in the areas close to the Hackensack River where fluctuating water levels have indicated the potential for exchange between the river and adjacent wetlands. This exchange of water would provide an additional opportunity for the wetlands adjacent to the river to provide water quality improvement. There would be an additional opportunity for treatment of shallow groundwater in these areas. Additional surface water flows may come from occasional tidal flooding as a result of leaking tidal gates, or in the case of severe storm events, overbank flows from the Hackensack River.

The hydrology studies of the Empire Tract wetlands indicated the primary water quality improvement potential of these wetlands on surface water appears to occur from sporadic events of overbank flooding of the creeks, as well as lateral movement of shallow groundwater from the creeks on site into the adjacent wetlands. Overbank flooding is thought to be infrequent, although the applicant's consultants indicated the site was inundated for a period of two to three weeks in May 1998. Lateral flow is more likely to occur during summer months, when evapotranspiration is sufficient to create a gradient between shallow groundwater and surface waters in the creek, allowing the movement to occur. The Empire Tract wetlands likely provide water quality improvement function by treating precipitation falling directly onto the wetland and into the creeks. Precipitation falling onto the site may carry nitrates, which are reduced in wetland soils by denitrification.

The prior qualitative discussion is based upon the hydrological opportunity for site wetlands to perform water quality functions. As a supplement to this analysis, USACE requested the applicant to perform a mass balance model of the site using information collected on the Empire Tract on both hydrology and water quality. Because of the complex hydrological conditions on site, and the difficulty the applicant encountered in collecting certain hydrological measurements such as velocity, the original approach recommended by USACE Waterways Experiment Station was modified significantly. Originally it was determined that the mass balance model would be developed by comparing flow-weighted loadings of selected water quality parameters at locations where storm water entered the site creeks to similarly measured loadings at the base of these creeks, where the creeks enter the Hackensack River. The result would be expected to provide a reasonable indication of the treatment function of site wetlands, and provide a model of contaminant flux as water moved through the wetland.

However, because velocity measurements could not be taken during the storm water sampling event, when water quality measurements were taken, this approach could not be adopted. In addition, it was determined that due to the periodically leaking tide gates, concentrations of several parameters measured were actually higher near the base of the site creeks than at the point where the creeks enter the site. Use of such an approach could result in erroneous conclusions regarding the water quality improvement function of these wetlands. As a result, the approach was modified by using modeled storm water events as an estimate of flow during the period in which analytical data on water quality parameters were collected. The TR-55 model developed by the U.S. Natural Resource Conservation Service was used to estimate flows for the precipitation event in which water quality data were collected, using precipitation data and site-specific channel data as inputs. In the absence of flow data collected concurrently with water quality sampling, hydrographs for the inflow and outflow stations were simulated with the TR-55 runoff model. The resultant model runs were compared to actual site data at locations where accurate velocity data were recorded; comparisons were made between flow measurements and predicted flows for multiple precipitation events monitored in the fall of 2000. Using volumes from the 27 comparisons (ratio of TR-55 volume to observed volumes), eight of the model estimates were within 20%, five were overestimated (161-461% increase in volume), and 14 were underestimated (24-96% decrease in volume). These comparisons indicate that the model results are highly variable for this site, and should be interpreted conservatively.

The results for the stations located near the base of the creeks, near their confluence with the Hackensack River, were affected by leaking tide gates from the Hackensack River. These results were adjusted accordingly based on the difference in salinity measured in the Hackensack River immediately below the site, and the salinity measured on site. Salinity is a conservative indicator of the amount of leakage that was occurring at these locations when originally measured. Based on these results it was assumed that 18% of the surface water measured at these locations consisted of river water, and the results were adjusted accordingly by normalizing them.

Results of the FLUX model analysis were derived based upon flow-weighted averages generated using the above TR-55 modeling approach as described in Walker (1996). It is recognized that these calculations represent a rough estimate of the potential of the site wetlands to treat contaminants based upon measurements from a single storm event. In addition, the approach adopted of comparing loadings entering the site versus those leaving the site does not explain in detail the processes that are actually occurring within the creeks and wetlands on the site. Nevertheless, this approach provides useful information in conjunction with the other hydrological data collected to provide an overall picture of the potential of these wetlands to perform certain water quality improvement functions. Limited extrapolation may be drawn from these results regarding seasonal trends, or the differences in functions performed by different areas of the site (e.g., wetlands adjacent to the creeks versus those located further away) since the hydrology of the site is complex. But the analysis provides a useful tool that in conjunction with the above-cited hydrological studies is sufficient to prepare an EIS addressing potential project impacts.

The FLUX analysis shows that site wetlands perform some treatment functions for both nitrate and phosphorus retention, as neither are shown to be exported (PS&S 2001b). Similarly, total suspended solids, an indicator of particulates found in storm water runoff, are also apparently retained by site creeks and not exported. Other parameters such as BOD and total organic carbon are exported from the site, which is consistent with site observations indicating export of peat material during storm events.

Sediment Toxicant Retention

Overview of Sediment Toxicant Retention Functions

The sediment toxicant retention function refers to the physical or chemical trapping and retention of the inorganic sediments or chemical substances generally toxic to aquatic life. These substances include heavy metals and organic compounds that can be toxic in aquatic food chains. In addition, while they are not considered toxic, compounds such as nitrogen and phosphorous can settle out into sediment.

Sediment may contain concentrations of heavy metals that accumulate over time in aquatic systems to levels that may be harmful to fish and wildlife, especially if suspended in the water column. For this reason, wetlands have been used extensively for treating drainage contaminated with heavy metals associated with acid mine drainage (reviewed in Kadlec and Knight 1996), as well as non-point source runoff (reviewed in Stockdale 1991). While plants such as common reed may accumulate metals via uptake in some systems (Ye et al. 1997), the primary means of metals removal in wetlands appears to be sedimentation and subsequent adsorption onto organic matter (Gambrell 1994; Mitsch and Wise 1998). As in the case of nutrients, the efficiency of removal is affected by the amount of loadings (Mitsch and Wise 1998); although wetlands are actually more efficient at treating influent with higher loadings, saturation of binding sites may eventually occur. Constructed systems for metals removal also are designed to control pH, allowing iron and other metals to flocculate out or become less available, and are designed to allow sufficient retention time for settling of sediments (Kadlec and Knight 1996).

In such constructed systems, the amount of flow and vegetation/water interface can be controlled. In a natural system, these factors can influence the amount of retention that actually occurs within a wetland as influenced by basin size and shape, and hydrological characteristics.

Sediment Toxicant Retention Functions of Empire Tract Wetlands

The effectiveness of sediment toxicant retention is largely dependent on the extent and duration of inundation of surface water. The slow-moving, nearly stagnant creeks present on the Empire Tract afford the opportunity for sediments present in storm water runoff from upgradient areas to settle out. Contaminants such as fecal coliform, metals and nutrients are subsequently afforded the opportunity to become sequestered by the peat material lining these creeks. Regarding the wetlands themselves, the ability of most of the wetlands on the Empire Tract to retain sediments is primarily limited to occasional periods of overbank flow. Based on hydrological information collected and hydrological modeling conducted on the Empire Tract, the existing common reed-dominated wetlands on the Empire Tract are inundated by surface flows infrequently. Berms and tidal gates limit most surficial tidal flows entering the site to those occurring during extreme storm events. Sheet flow (overland runoff as opposed to flow within a channel) does not appear to be the primary source of sedimentation or toxic substances entering the wetlands on the Empire Tract.

Most of the storm water that enters the Empire Tract comes from Moonachie Creek and storm water drainage pipes, and since the storm water does not inundate the wetlands under normal circumstances, there is a limited opportunity for sedimentation and filtering to occur (PS&S 2000a). Therefore, the opportunity for these non-tidal wetlands to allow sedimentation is expected to be lower than other (tidal) wetlands in the HMD that are regularly inundated. Since most of the wetlands on site have a restricted outlet, exhibit little or no flow, and are located in an urbanized area where non-point source runoff carries nutrients and other pollutants, the wetlands on the Empire Tract are considered to have less value for retention of toxicants compared to tidally inundated systems.

Some water quality improvement function may also be provided via adsorption of metals and other substances onto the roots of common reed plants growing in proximity to the on-site creeks that carry storm water runoff from the developed watershed upgradient of the Empire Tract. Wetlands can provide removal of toxic contaminants from shallow groundwater to the extent that groundwater comes into contact with the rooting zone of plants or organic matter deposited within the wetland over time. Some sediment toxicant retention function would thus be anticipated to occur as a result of shallow groundwater flow through the wetland. Results of studies indicates that the subsurface flow from these creeks into the shallow groundwater of the adjacent wetlands is limited to the summer months when the groundwater elevations decrease, allowing a sufficient gradient for water movement to occur from the creeks into the adjacent wetlands (PS&S 2001a).

6.2.3.5.2 Fish, Wildlife and Aquatic Community Values

Overview of Wildlife Functions

The "wildlife" function refers to the capacity of a wetland to support on-site diversity or abundance of a variety of species groups, such as birds, fish, mammals, amphibians and reptiles. The focus of this discussion is on species groups that are of management priority in the Hackensack Meadowlands, namely wading birds, shorebirds, juvenile fish, and waterfowl. Section 6.5 provides a discussion of wildlife habitat in general

Wildlife Functions of the Empire Tract

Section 6.5 of the FEIS provides an assessment of the specific wildlife habitats of the Empire Tract. The Empire Tract is located within a larger mostly undeveloped area of marsh that is a corridor for migrating birds between the northern and southern portions of the Meadowlands. Results of the avian survey conducted at the Empire Tract (TAMS 1997) indicate that the site itself offers limited habitat for shorebirds and waterfowl. This is because these species were recorded at a far lower frequency than other species during a yearlong survey of the Empire Tract. Also they are known to favor and often congregate in areas of suitable habitat (e.g. open water, mudflat and emergent wetland areas) during migration. The congregations have not been observed on the Empire Tract, and the habitat area for waterfowl is limited to areas within and immediately adjacent to the site creeks.

Overview of Waterfowl Functions

The "waterfowl" function refers to the ability of a wetland to support on-site diversity or abundance of waterfowl, such as ducks and geese. Section 6.5 provides a discussion of waterfowl habitat value in general.

Waterfowl Functions of Empire Tract Wetlands

Waterfowl habitat on the Empire Tract is limited to the 14 acres of shallow water (unvegetated bottom) habitat, 10 acres of tidal emergent marsh 2 acres of vegetated shallow water habiat, and 11 acres of mudflat. Of those habitats, vegetated shallow water habitat is most used by waterfowl species referred to as "dabbling ducks" such as mallards, gadwall, pintail and teal (USFWS 1988). This habitat is also used by Canada geese.

Wading bird and shorebird habitat at the Empire Tract is primarily provided by 27 acres of shallow water habitat that includes 2 acres of vegetated shallows, 14 acres of open water areas with unvegetated bottom, and 11 acres of mud flats associated with the creeks crossing the site, and the shoreline of the Hackensack River (Section 6.5). Open water habitat is used by herons and egrets, while mudflat and vegetated shallows could be used by shorebirds.

The dense stands of common reed on site, while providing undisturbed open space, provide limited habitat for waterfowl or shorebirds, but would be expected to provide habitat for some water-dependent bird species such as rails or bitterns. The quality of the common reed habitats can be considered less than what would be present if the area was regularly inundated by the tides (Roman et al. 1984), or freshwater flows, as evidenced by a number of tidal restoration programs in the northeastern United States (Sinicrope et al. 1990 citing ongoing restoration efforts in the HMD and PSE&G sites along the Delaware River, and others).

Overview of Aquatic Diversity and Abundance Functions

The aquatic diversity and abundance function indicates the probability that populations of fish or aquatic invertebrates occurring within a wetland are large and diverse. Therefore, this function is an important indicator of a wetland's biological value and overall productivity and its value for fish, wildlife, and waterfowl. Sections 6.4 and 6.6 address aquatic diversity and abundance functions in general.

Aquatic Diversity and Abundance Functions of Empire Tract Wetlands

Existing on-site fish and benthic habitat consists of approximately 14 acres of on-site creeks and ditch channels. The common reed-dominated wetlands are not regularly inundated and thus do not provide habitat for fish or benthic invertebrates, but do support populations of other aquatic invertebrates such as insects (see Section 6.6). Four species of fish and six benthic taxa are known to occur currently on the Empire Tract (see Section 6.4 and Section 6.6). Ten fish species that have not been observed on the site have been observed in the Hackensack River adjacent to the Empire Tract. Results of fish surveys on the Empire Tract (see Section 6.4) indicate that many of these species may be unable to access and utilize the site in its existing condition due to the presence of tide gates and berms.

Overview of Fish Functions

The general fish function indicates a wetland's capacity to support on-site diversity or abundance of fish species. Section 6.4 addresses fish habitat in general.

Fish Functions of Empire Tract Wetlands

As discussed above for aquatic diversity and abundance, existing on-site fish habitat is limited to approximately 14 acres of on-site creeks and ditch channels. The majority of the wetlands on the Empire Tract are not regularly inundated and thus do not provide habitat for fish under normal circumstances. Four species of fish are known to occur currently on the Empire Tract; one is an estuarine species, the banded killifish, while the remainder is primarily freshwater species (Section 6.4).

Overview of Production Export Function

The production export function refers to the flushing of organic plant material (specifically, net annual primary production) produced in a wetland and then transported into down slope waters. Net annual primary production is referred to as the amount of organic material (usually vegetation) produced annually in an ecosystem (Whittaker 1975). The amount of organic carbon export from a wetland can be thought of as a function of flow characteristics, as well as the amount of organic matter present within a wetland (Brinson et al. 1995). This, in turn, is influenced by living biomass, as well as litter.

Dead vegetation in various stages of decay, live plant material, seeds, plankton, invertebrates, and fish can be produced in a wetland and exported downstream. This organic matter then can become a nutrient source for plants and animals far away from the wetland where it was produced.

Production Export Function of Empire Tract Wetlands

The existing common reed-dominated wetland habitats on the Empire Tract produce large amounts of organic matter as plants die back annually. Studies in the literature have shown the net annual production of organic matter by common reed in tidal freshwater systems may average 1,872 g/m^2 per year or higher (Mitsch and Gosselink 1993). In contrast, tidal salt marshes dominated by smooth cordgrass in Rhode Island and New York ranged from 507-840 g/m^2 per year. Thus while the existing common reed wetlands on the Empire Tract are non-tidal, their net annual productivity is still likely to be higher than some tidal wetland systems.

However, production export also requires that there be an opportunity for organic material to be hydraulically transported from the wetland. Generally, surface flows would be considered to be the primary route. Most wetlands on the Empire Tract are inundated only infrequently. As a result, the current rates of production export from the Empire Tract are likely to be low relative to other tidally influenced or inundated freshwater wetlands in the HMD. This is because production export is dependent upon flushing of organic material from the site into downstream waters, and frequency and duration of inundation in the existing Empire Tract is low.

However, shallow groundwater entering the creeks from the wetlands on site would be expected to transport some suspended and dissolved forms of organic carbon into the site waterways leading off site into the Hackensack River. This is because the surface layer of the marsh consists primarily of organic peat. In a field reconnaissance in March 2000, USACE representatives observed that the lower portion of Moonachie Creek was a dark brown color after a precipitation event, indicative of the export of organic carbon (USACE 2000). Total organic carbon (TOC) was one of the parameters measured as part of the water quality sampling program to determine mass balance (PS&S 2001b). Mass balance results indicated a net export of TOC.

6.2.3.5.3 Social Significance Values

Overview of Recreation Function

The recreation function refers to the ability of a wetland to support recreational activities.

Recreation Function of Empire Tract Wetlands

The Empire Tract is privately owned land that generally is not developed or known to be used for recreational use. The Empire Tract presently does not provide significant recreational access or opportunities in its existing condition. Because the site may be seen from the Hackensack River, it offers aesthetic value.

Overview of Flood Flow Alteration Function

The flood flow alteration function refers to a wetland's ability to detain floodwaters, and lessen peak flood velocity and elevation, thereby protecting downstream areas from flooding. Tidal wetlands have a limited potential for detaining floodwaters or lessening peak flood velocity and elevation because they are often flooded already. Thus, their available storage capacity is accounted for by regular tidal inundation. Section 6.1 provides an overview of the hydrological cycle which influences flooding; flooding issues are further discussed in Section 6.13.

Flood Flow Alteration Function of Empire Tract Wetland

Since the existing wetlands at the Empire Tract are not subject to regular tidal inundation, they have more flood storage capacity than other wetlands in the HMD that are tidally inundated. While the Empire Tract wetlands do not presently prevent regional tidal flooding, properties, storm water modeling results of the Empire Tract (see Section 6.13) indicate that the wetlands on site act to reduce flooding of adjacent properties during *fluvial* storm events. The hydrological modeling results indicate that flooding of the Empire Tract when it occurs, as well as flooding in areas upstream of the site, is largely a result of tidal flow. Some flood protection to adjacent properties is also offered by dikes along the New Jersey Turnpike (see Section 6.13). This protection is not considered a wetland function, but is considered an indirect engineering control.

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6.3 WATER QUALITY

6.3.1 Overview

6.3.1.1 Water Quality Concerns Pertinent to the Proposed Development

Existing water quality conditions on site and in the immediate surrounding area are discussed in this section to provide a baseline by which potential effects of the proposed development may be assessed. Water quality affects drinking water supplies, habitat quality for fish and wildlife, recreational opportunities in regional water bodies, and overall aesthetics of a water body.

Neither surface waters nor groundwater from the Empire Tract are used as a potable water source. The water supply for the proposed Meadowland Mills development would be provided by the United Water Company in Hackensack, NJ, which serves the local Boroughs of Carlstadt and Moonachie and the Town of South Hackensack (TAMS 1998). The water on the Empire Tract is not used for recreation. Thus, the principal water quality concerns pertinent to the proposed development involve the extent to which:

- existing quality of on-site water bodies influences the nature and quality of habitat provided for fish and wildlife;
- the site wetlands treat water (by natural processes) entering the site from storm water runoff and possibly groundwater, under present conditions (see Section 6.2.2);
- the wetlands on the Empire Tract influence Hackensack River water quality; and
- the proposed development would influence water quality of the Empire Tract and adjacent Hackensack River (see Section 7.3).

6.3.1.2 Characterization of Water Quality

Water quality is typically characterized using a number of parameters (USEPA 1986). Parameters such as salinity and total dissolved solids (TDS) are influenced by natural processes, and can be used to establish baseline water quality conditions such as the extent of freshwater conditions on site. Other parameters that are influenced directly by human activities can be used to indicate the extent of impairment of the aquatic ecosystem.

Typical parameters used to characterize water quality include dissolved oxygen (DO), which is important to the survival of fish and other aquatic life, and biochemical oxygen demand (BOD), which is an indicator of how much oxygen might be used by material in the water column. BOD is considered a measure of oxygen consumed by microorganisms as well as oxygen used to oxidize inorganic material such as sulfides and ferrous iron (Eaton et al. 1995). BOD is also influenced by high amounts of organic material and/or ammonia in the water column or sediments. These and other compounds may sequester oxygen molecules that might otherwise be available to support aquatic life. Chemical oxygen demand (COD) is a separate measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (Eaton et al. 1995). Other important water quality parameters include salinity; temperature; TDS;

total suspended solids (TSS); pH (acidity); conductivity; turbidity (an indicator of the clarity of the water column); nutrients such as nitrates and phosphates (indicators of eutrophication); and toxic compounds such as heavy metals, petroleum chemicals, solvents, and pesticides. In addition, fecal coliform bacteria are an indicator of bacterial pollution often associated with sewage effluent.

Water quality parameters measured are often interrelated. For example, DO generally increases as temperature decreases. BOD is related to organic matter in the water column and is often inversely proportional to DO. Furthermore, if, for example, the organic matter present originated at a sewage treatment plant, then fecal coliform levels might be correlated with the presence of nitrates, phosphates, and increased BOD in the water column.

6.3.1.3 Regulatory Classification of Water Bodies

In New Jersey, water quality is regulated by the NJDEP, which has assumed regulatory responsibility for certain programs under the Clean Water Act. The State of New Jersey establishes water quality standards for several parameters, including those discussed above. NJDEP classifies water bodies of the state by usage, and establishes water quality standards that should be met for each parameter within each water body. In most cases the standards are concentrations that should not be exceeded in the water body. An exception is the standard for DO, which represents a minimum value that should be met.

Surface waters on and in the immediate vicinity of the Empire Tract have a NJDEP classification of either FW-2 NT (freshwater non-trout) or SE-2 (estuarine). Freshwater bodies in the State of New Jersey that are classified as FW-2 NT normally have salinity values less than or equal to 3.5 parts per thousand (ppt) and have the following designated uses:

- maintenance, migration and propagation of natural and established biota;
- primary and secondary contact recreation;
- industrial and agricultural water supply;
- public potable water supply after such treatment as required by law or regulation; and
- any other reasonable uses.

Tidal water bodies classified as SE-2 are estuarine waters with the designated uses of:

- maintenance, migration and propagation of natural and established biota;
- migration of diadromous fish;
- maintenance of wildlife;
- secondary contact recreation; and
- any other reasonable uses.

6.3.2 Regional Setting

6.3.2.1 Lower Hackensack River Water Quality

The principal hydrologic feature in the vicinity of the Empire Tract is the Hackensack River (see Section 3.11). While surface waters on the Empire Tract have been largely isolated from the Hackensack River by a series of tidal gates and berms, a brief discussion of river water quality is provided in this section. This is because the proposed brackish wetland mitigation plan (see Section 8.1) would reintroduce river water to a portion of the Empire Tract that is not presently inundated under normal circumstances. In addition, a portion of the existing wetlands at the Empire Tract may also be hydraulically connected with the Hackensack River by creek water moving laterally from the creeks into the wetland shallow groundwater during certain periods of the year; thus, the wetlands may indirectly act by natural filtration to improve water quality in the river.

The lower Hackensack River flows into Newark Bay, which is part of the larger New York/New Jersey Harbor estuary and is considered one of the most degraded estuarine systems in the United States (Long et al. 1995). Surface waters in the lower portion of the Hackensack River in the vicinity of the Empire Tract are classified by the NJDEP as SE-2 (NJAC 7:9B-1.15). Water quality of the lower Hackensack River is primarily influenced by Newark Bay, since the river is tidal in this area. According to water quality modeling conducted for the Bergen County Utilities Authority (BCUA), nearly 70% of the total pollutant load into the lower Hackensack River originates from Newark Bay (CBA 1990) and moves upstream during high tide.

Results of prior studies (CBA 1990; USEPA and USACE 1995) indicate the lower Hackensack River estuary has poor circulation and is not well flushed, contributing to water pollution problems. Flushing is typically enhanced by freshwater inflows; however, these were reduced after the river was dammed and the Oradell Reservoir was constructed in 1922 (USEPA and USACE 1995). Poor circulation in the estuary has been attributed to the fact that the connection of the estuary with the open sea is only indirect, via Newark Bay (USEPA and USACE 1995).

In addition to polluted water entering from Newark Bay, water quality within the lower Hackensack River has been impaired as a consequence of wastewater and storm water discharges, combined sewer overflows (CSOs), emergency sewage overflows, hazardous waste sites, power plant thermal discharges, and landfills within the vicinity (USEPA and USACE 1995). However, since the 1970s, water quality within the Hackensack River has steadily improved (USEPA and USACE 1995), consistent with regional trends in the New York/New Jersey Harbor estuary, as a consequence of technological advances in wastewater treatment, and implementation of the Clean Water Act (Crawford et al. 1994).

6.3.2.2 Water Quality Studies in the Hackensack River Adjacent to the Empire Tract

Numerous water quality studies have been conducted in the Hackensack River near the Empire Tract and in off-site tributaries. These are summarized below.

Bergen County Utilities Authority (BCUA) Studies

The BCUA operates an approximate 78-million-gallons-per-day (mgd) wastewater treatment facility located immediately upriver from the Empire Tract. The BCUA has conducted extensive water quality studies, and modeled water quality within this stretch of the Hackensack River (CBA 1990).

The SAMP DEIS (USEPA and USACE 1995) summarized results of the BCUA modeling effort, which was based on water quality data collected in 1988 and 1989. The following results suggested by the model are pertinent to describing the water quality of the river within the vicinity of the Empire Tract:

- Low DO and high pollutant concentrations were detected in the lower Hackensack River during the summer months of the BCUA study. Causes of DO depletion in the Hackensack River included wastewater discharges from the BCUA sewage treatment plant (approximately 78 mgd), landfills, and storm water discharges.
- DO depletion was historically exacerbated by thermal discharges from the PSE&G Bergen Generating Station in Ridgefield, but that situation has since been rectified.
- The marshes in the HMD act as a net source of DO to the Hackensack River system, resulting from primary productivity on the marsh surface and increased aeration from water movement through emergent vegetation (USEPA and USACE 1995).

Since the BCUA study was completed in 1990, thermal discharges from the PSE&G plant have been eliminated, and a portion of the BCUA's treated wastewater is now pumped to the PSE&G facility for use as non-contact cooling water (TAMS 1998). As a result, water quality in the river has improved.

NJMC and U.S. Geological Survey Studies

The NJMC (formerly referred to as HMDC) and the U.S. Geological Survey (USGS) have continued to monitor water quality conditions in the HMD from 1993 to the present, for selected parameters such as DO, turbidity, heavy metals and fecal coliform bacteria. Two of the 14 monitoring stations are located in the Hackensack River near the Empire Tract (Figure 6.3-1). NJMC's Station 2 is located near the northern end of the Empire Tract at the New Jersey Turnpike bridge downstream of the BCUA Sewage Treatment Plant in Little Ferry, and Station 3 is near the southern end of the site near Bashes Creek.

NJMC (Konsevick et al. 1994) documented results of the four seasonal sampling events conducted in 1993 and 1994. NJMC conducted additional sampling from February 1995 through March 1997 and

Water Quality Sampling Locations

Source: USEPA and USACE, 1995.

Figure 6.3-1

in 1997 through 2000. Data from Stations 2 and 3 are provided in Table 6.3-1, Table 6.3-2 and Table 6.3-3. A summary of data collection methods associated with the NJMC monitoring program is provided in Konsevick et al. (1997). Surface water quality monitoring is conducted quarterly, and results are related to precipitation data collected during the same time period. The 1997 report concluded that the overall health of the Hackensack River is improving, since:

- No summer depletion of dissolved oxygen occurred at the points monitored in the Hackensack River;
- Heavy metal concentrations were well below criteria limits, and have become lower during the sampling period from 1993-2000; and
- Fecal coliform bacteria, while still high in some areas, has shown an overall reduction in concentrations.

6.3.2.3 Lower Hackensack River Water Quality Data Summary

The results of the various studies conducted on the Lower Hackensack River indicate that the river within the vicinity of the Empire Tract has seasonally low DO levels, and is impacted by pollutants such as heavy metals (cadmium, lead, and zinc) and fecal coliform bacteria. As a result, habitat for fish and wildlife has become degraded relative to historical conditions before development of the region. The following is a discussion of selected water quality parameters within the Hackensack River in the vicinity of the Empire Tract.

Salinity

The salinity data from 1993 to 2000 suggest that the Hackensack River in the vicinity of the Empire Tract exhibits fresh and brackish conditions at different times. Factors influencing salinity in an estuary include tides, freshwater inflows resulting from precipitation, evaporation, weather conditions affecting wind, distance from the mouth of the estuary, and river basin geomorphology (Kennish 1992). As evidenced in the 1995-1997 data (Table 6.3-2), salinity values in the vicinity of the Empire Tract ranged from 0.2 to 8.4 ppt. Salinity values for the Empire Tract from 1997 to 2000 (Table 6.3-3) were in the range of 0.5 to10.4. Salinity values recorded during this period were typically 1 to 2 ppt greater at the downstream station (Station 3) compared to the upstream station (Station 2). By comparison, the surface salinity of the open ocean is approximately 35 ppt (Thurman 1975). The salinity of freshwater bodies is defined by the State of New Jersey as <3.5 ppt, but freshwater wetland systems are defined by the USFWS as having a salinity value <0.5 ppt (Cowardin et al. 1979).

Turbidity

Turbidity is a measure of the clarity of the water column, which is a function of suspended particles (Thurman 1975) and is recorded as nephelometric turbidity units (NTUs). Turbid (cloudy) water can be caused by natural conditions (e.g., tidal flushing and resultant suspension of sediments), water from aquifer formations that is naturally elevated in total dissolved solids, or human activities, such as the release of suspended particles in urban runoff or wastewater discharges into the river.

Turbidity is often elevated in areas near the mouth of estuaries, where tidal action and river flows result in great mixing. Turbidity measurements recorded from 1995 to 1997 exceeded the NJDEP estuarine (SE-2) standard at both Hackensack River stations at least part of the time (Table 6.3-2); measurements collected from 1997 to 2000 did not exceed the standard. Concentrations of TDS, a parameter often related to turbidity, did not exceed the NJDEP SE-2 standard from 1993 to 2000.

Dissolved Oxygen

Dissolved oxygen concentrations in the water column are influenced by temperatures, photosynthesis, respiration of aquatic life, reaeration from physical processes, amount of organic matter, and pollutant inputs (USEPA 1986). The 1993-1994 results indicated that the average DO concentrations at the two Hackensack River stations closest to the Empire Tract measured over the four sampling events were greater than the NJDEP SE-2 minimum standard of 4 milligrams per liter (mg/L). However, the July 1993 concentrations (1.9 mg/L at Station 2 and 2.3 mg/L at Station 3) were well below the minimum standard. These results indicate that seasonal depletion of oxygen was occurring, to the potential detriment of aquatic life. Subsequent data collected from 1995 to 1997 indicated that average DO concentrations at both stations met the minimum NJDEP SE-2 standard, but two of the nine readings at Station 2 and one of the nine readings at the downstream station did not. The average DO concentrations at both stations also met the minimum NJDEP SE-2 standards for 1997 to 2000 (Table 6.3-3). These limited data suggest that in the vicinity of the Empire Tract, the DO concentrations have gradually improved. However, despite the fact that thermal discharges from the PSE&G plant have ceased, some seasonal oxygen depletion still apparently occurs within the estuary during summer months.

Dissolved oxygen concentrations in the lower Hackensack River are influenced by inputs such as organic matter to the estuary, as well as chemicals that use available oxygen in the water column. Both BOD and COD can vary widely with storm events since storm water runoff tends to carry with it particles of organic matter as well as chemicals such as nitrates (e.g., from lawn fertilizers or animal wastes) that sequester oxygen molecules. For example, BOD concentrations at NJMC Station 2 (upstream of the Empire Tract) ranged from 1.1 mg/L to 10.4 mg/L in eight samples collected during the period from 1995 to 1997. From 1997 to 2000, BOD concentrations ranged from 4.2 mg/L to 13.0 mg/L. At Station 3 the concentrations varied from 2.1 mg/L to 28.8 mg/L from 1995 to 1997, and from 2.3 mg/L to 9.6 mg/L from 1997 to 2000. COD concentrations were higher, ranging from 15.6 mg/L to 123 mg/L at Station 2, and from 20.9 mg/L to 176 mg/L at Station 3 during 1995 to 1997 and from 20.1 mg/L to 103.0 mg/L at Station 2, and from 22.6 mg/L to 138.0 mg/L at Station 3 during 1997 to 2000.

The BOD and COD concentrations recorded suggest that DO levels in the estuary are influenced by organic and chemical inputs; the BOD and COD levels recorded are indicative of an urban tidal river.

Heavy Metals

Heavy metals include elements such as cadmium, chromium, lead, nickel, and zinc that can adversely affect aquatic biota on the cellular, organismic or population level (Suter et al. 1993). Concentrations of heavy metals in surface water measured in 1993-1994 at the two Hackensack River stations closest to the Empire Tract (Table 6.3-1) were within the range of concentrations detected at the remaining HMD stations (Konsevick et al. 1994). Average metals concentrations measured from 1995 to 1997 (Table 6.3-2) as well as 1997 to 2000 (Table 6.3-3) at these two locations fell within the same range or were less than those measured in 1993 to 1994. Heavy metals concentrations measured at these two locations from 1995 to 1997 did not exceed any of the NJDEP SE-2 standards. However, because SE-2 standards do not exist for cadmium, lead or zinc, concentrations of these metals could not be compared to NJDEP criteria. Cadmium, lead and zinc concentrations did exceed the USEPA (1992) saltwater "continuous concentration criteria" for chronic exposure (Table 6.3-2), indicating that water quality at these locations in the river continues to pose a potential risk to aquatic life.

Fecal Coliform Bacteria

Fecal coliform bacteria in the water column are often associated with poorly treated human waste, but can also originate from other animal wastes (e.g. pets in urban and suburban areas). As a result they are often present in urban and suburban runoff.

In addition to storm water discharges, fecal coliform are often present in sewage effluent. Fecal coliform counts measured at Hackensack River Stations 2 and 3 from 1993 to 1994 (Table 6.3-1) exceeded the SE-2 standard at least part of the time (TAMS 1998). However, subsequent data from 1995 to 1997 (Table 6.3-2) indicated that the geometric mean of the fecal coliform counts at each station was less than the geometric mean-based NJDEP standard. Data from 1997 to 2000 (Table 6.3-3) yielded averages lower than that of the NJDEP SE-2 standards. Levels of fecal coliform bacteria are often correlated with low DO and high BOD, which also have been observed in the Hackensack River.

Table 6.3-1

Hackensack River Water Quality Concentrations Near the Empire Tract (NJMC (then HMDC) 1993-1994 Data)

Parameter	Unit	NJ Surface Water Standard (C,D)	Station 2 (Upstream)		Station 3 (Downstream)	
			Range	Average (A)	Range	Average (A)
pH	--	6.5-8.5	7.1-7.5	7.3 (6)	7.1-7.5	7.3 (6)
Salinity	ppt	>3.5 (SE2)	2.7-8.1	5.1 (6)	3.6-10.5	7.2 (6)
DO	mg/L	4.0 (min)	ND-6.7	4.4 (6)	2.3-8.0	4.8 (6)
BOD	mg/L	--	4.5-31.0	13.4 (5)	ND-13.7	5.9 (5)
COD	mg/L	--	32.2-153.0	85.1 (6)	40.0-170.0	104.6 (6)
TSS	mg/L	40	9.7-128.0	45.0 (6)	18.3-143.0	57.0 (6)
Turbidity	NTU(E)	30 (SE2)	2.0-13.0	6.4 (6)	4.0-10.2	6.7 (6)
Fecal Coliform	#/100mL	770 (SE2) (GM)	20-9,000	2218 (6) GM=500 (B)	300-1,700	950 (6) GM=748 (B)
Ammonia	mg/L	--	ND-9.3	7.9 (4)	2.8-8.2	5.3 (5)
Cadmium	□g/L	10 (FW2) 9.3 (USEPA CCC)	ND-95.1	48.0 (4)	ND-91.6	43.2 (5)
Chromium	□g/L	3,230 (SE2)	ND-30.1	19.8 (4)	215.1-65.7	34.8 (5)
Lead	□g/L	3.5 (FW2) 8.5 (USEPA CCC)	ND-1,020	357.7 (5)	9.1-718.0	295.4 (6)
Nickel	□g/L	3,900 (SE2)	25.4-408.0	1,727 (5)	25.4-300.0	182.7 (5)
Zinc	□g/L	86 (USEPA CCC)	59.7-206.0	123.4 (5)	21.0-175.0	86.3 (6)

Notes: A. Numbers in parentheses represent number of observations.
B. GM=Geometric mean used for comparison to fecal coliform standard.
C. FW2 standard provided for those parameters that do not have a SE2 standard.
D. USEPA (1992) saltwater criterion for continuous concentration (CCC) provided for those parameters that do not have a NJ SE-2 standard. FW-2 and SE-2 represent NJ freshwater and estuarine water quality standards.
E. NTU =Nephelometric turbidity units; a measure of light penetration into the water column.
F. COD = chemical oxygen demand; a measure of oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (Eaton et al., 1995).
ND= Not detected

Source: Data from NJMC File "Master Spreadsheet 1993-1999.xls".

Table 6.3-2
Hackensack River Water Quality Concentrations Near the Empire Tract
(NJMC (then HMDC) February 1995 - March 1997 Data)

Parameter	Unit	NJ Surface Water Standard (C,D)	Station 2 (Upstream)		Station 3 (Downstream)	
			Range	Average (A)	Range	Average (A)
pH	--	6.5-8.5	7.1-7.7	7.4 (9)	6.9-7.6	7.4 (9)
Salinity	ppt	>3.5 (SE2)	0.2-6.1	2.8 (9)	0.3-8.4	4.3 (9)
DO	mg/L	4.0 (min)	2.0-12.9	7.3 (9)	1.6-10.7	6.9 (9)
BOD	mg/L	--	1.1-10.4	5.6 (8)	2.1-29.8	7.9 (8)
COD	mg/L	--	15.6-123	55.6 (9)	20.9-176	77.3 (9)
TSS	mg/L	40	9.3-69	28.3 (9)	0.6-93.9	34.1 (9)
Turbidity	NTU(E)	30 (SE2)	8-126	23 (9)	5-285	40 (9)
Fecal Coliform	#/100mL	770 (SE2) (GM)	20-9,000	1,480 (9) GM=320 (B)	<20-9,000	1,930 (9) GM=350 (B)
Ammonia	mg/L	--	0.5-6.8	3.8 (9)	1.8-5.6	4.0 (9)
Cadmium	□g/L	10 (FW2) 9.3 (USEPA CCC)	1.7-19.3	7.8 (9)	4.3-24.7	13.0 (9)
Chromium	□g/L	3,230 (SE2)	1.1-16.8	6.8 (9)	2.5-24.0	13.5 (9)
Lead	□g/L	3.5 (FW2) 8.5 (USEPA CCC)	19.5-175	74 (9)	34.6-250	89 (9)
Nickel	□g/L	3,900 (SE2)	10.6-222	70 (9)	15-256	103 (9)
Zinc	□g/L	86 (USEPA CCC)	18-174	53 (9)	19-180	64 (9)

Notes: A. Numbers in parentheses represent number of observations.
B. GM=Geometric mean used for comparison to fecal coliform standard.
C. FW2 standard provided for those parameters that do not have a SE2 standard.
D. USEPA (1992) saltwater criterion for continuous concentration (CCC) provided for those parameters that do not have a NJ SE-2 standard. FW-2 and SE-2 represent NJ freshwater and estuarine water quality standards.
E. NTU =Nephelometric turbidity units; a measure of light penetration into the water column.
F. COD = chemical oxygen demand; a measure of oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (Eaton et al., 1995).

Source: Data from NJMC File "HR23WQ.XLS" dated May 22, 1997.

Table 6.3-3
Hackensack River Water Quality Concentrations Near the Empire Tract
(NJMC (then HMDC) 1997-2000 Data)

Parameter	Unit	NJ Surface Water Standard (C,D)	Station 2 (Upstream)		Station 3 (Downstream)	
			Range	Average [A]	Range	Average [A]
pH [B]	--	6.5-8.5	6.4 - 7.8	7.0 (14)	5.8 - 7.8	6.9 (14)
Salinity	ppt	>3.5 (SE2)	0.5 - 8.6	3.5 (14)	1.0 - 10.4	5.4 (14)
DO	mg/L	4.0 (min)	2.3 - 11.2	7.6 (14)	1.7 - 11.1	5.9 (14)
BOD	mg/L	--	4.2 - 13.0	7.3 (13)	2.3 - 9.6	5.3 (13)
COD(F)	mg/L	--	20.1 - 103.0	56.6 (13)	22.6 - 138.0	67.0 (13)
TSS	mg/L	40	5.4 - 52.0	25.4 (13)	1.9 - 43.7	20.1 (13)
Turbidity	NTU(E)	30 (SE2)	5.1 - 18.0	11.1 (13)	6.5 - 21.0	12.9 (13)
Fecal Coliform[B]	#/100mL	770 (SE2)	20 - 5000	150 (14)	20.2 - 1400	218 (14)
Ammonia	mg/L	--	2.4 - 8.6	5.9 (13)	2.0 - 7.4	5.1 (13)
Cadmium	µg/L	10 (FW2)	3.1 - 20.5	10.0 (13)	1.6 - 35.9	15.8 (13)
Chromium	µg/L	3,230 (SE2)	2.7 - 16.5	9.2 (13)	5.4 - 21.3	11.9 (13)
Lead	µg/L	5 (FW2)	12.5 - 116.0	55.4 (13)	20.4 - 207.0	94.7 (13)
Nickel	µg/L	3,900 (SE2)	17.5 - 159.0	62.2 (13)	22.1 - 216.0	89.1 (13)
Zinc	µg/L	--	13.6 - 61.1	37.2 (13)	16.6 - 55.3	36.6 (13)

Notes: A. Numbers in parentheses represent number of observations.
B. GM=Geometric mean used for comparison to fecal coliform standard.
C. FW2 standard provided for those parameters that do not have a SE2 standard.
D. USEPA (1992) saltwater criterion for continuous concentration (CCC) provided for those parameters that do not have a NJ SE-2 standard. FW-2 and SE-2 represent NJ freshwater and estuarine water quality standards.
E. NTU =Nephelometric turbidity units; a measure of light penetration into the water column.
F. COD = chemical oxygen demand; a measure of oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (Eaton et al., 1995).
ND= Not detected

Source: Data from NJMC File

6.3.3 Empire Tract

Water quality is a primary determinant of habitat quality for fish and wildlife. Parameters such as salinity, DO, BOD, pH, and heavy metals are important influences on the survival of aquatic life. Because the Empire Tract is undeveloped, the surface water quality of the creeks and wetlands on site is influenced primarily by off-site influences that include storm water runoff from areas upgradient within the watershed, groundwater flows, precipitation, and occasional intrusion of river water onto the site via leaking tide gates.

6.3.3.1 Empire Tract Water Quality Studies

Several water quality investigations have been conducted on and in the immediate vicinity of the Empire Tract since 1978. These are summarized below, with sampling locations indicated on Figure 6.3-1.

HMDC (now NJMC) Study 1978-1988 (DO, Salinity)

Dissolved oxygen and salinity concentrations were measured at 14 stations within the HMD by NJMC from 1978 to 1988. One sampling location was located on the Empire Tract (Station 13), on Moonachie Creek just downstream of the New Jersey Turnpike. This station is tidally influenced by the Hackensack River.

ERM/GES 1984 Field Investigation (Conventional Water Quality Parameters)

In 1984, ERM/GES, Inc. collected surface water and sediment samples at six locations (Figure 6.3-1). Three stations were located in Moonachie Creek, located upstream (Station M3), midstream (Station M2), and downstream (Station M1) of the Empire Tract. One location was sampled in Bashes Creek at the downstream limit of the Empire Tract (Station B1), and another in Muddabach Creek at the downstream limit of the Empire Tract. These stations were all located upstream of the tide gates on their respective creeks. The sixth station was located off site in the Hackensack River near the New Jersey Turnpike Bridge (Station HR).

Surface water samples were analyzed for conventional water quality parameters, including salinity, pH, DO, nutrients (phosphorus and nitrogen), BOD, total and fecal coliform bacteria, and others. Results are presented in Table 6.3-4.

TAMS 1991 Investigation (Salinity, Temperature and Groundwater)

In the summer of 1991, TAMS conducted on-site sampling consisting of field measurements of salinity and temperature in surface water and groundwater at numerous locations throughout the Empire Tract. The data are tabulated in the Environmental Impact Assessment Report (EIAR) (NJMC, 1992). A discussion of groundwater conditions and salinity data in groundwater is provided in Section 6.3.3.4.

TAMS 1996 Investigation (Conventional Parameters, Metals, Storm Water Discharge)

In March 1996, during a rain event, TAMS sampled discharges from outfalls and surface water from ditches and creeks at five locations entering the Empire Tract at the western and northern boundaries (see Figure 6.3-1). Samples were collected after approximately 0.4 inch of precipitation fell during a total precipitation event of approximately 0.7 inch over 24 hours. These samples were analyzed for conventional parameters as well as select metals, including chromium, lead, and zinc. The data represent the expected quality of water entering the Empire Tract. A summary of the data with the relevant NJDEP surface water standards for FW-2 NT streams in New Jersey is presented in Table 6.3-6. The FW-2 NT standards were used for comparison since salinity data from the streams indicated concentrations were less than 3.5 ppt.

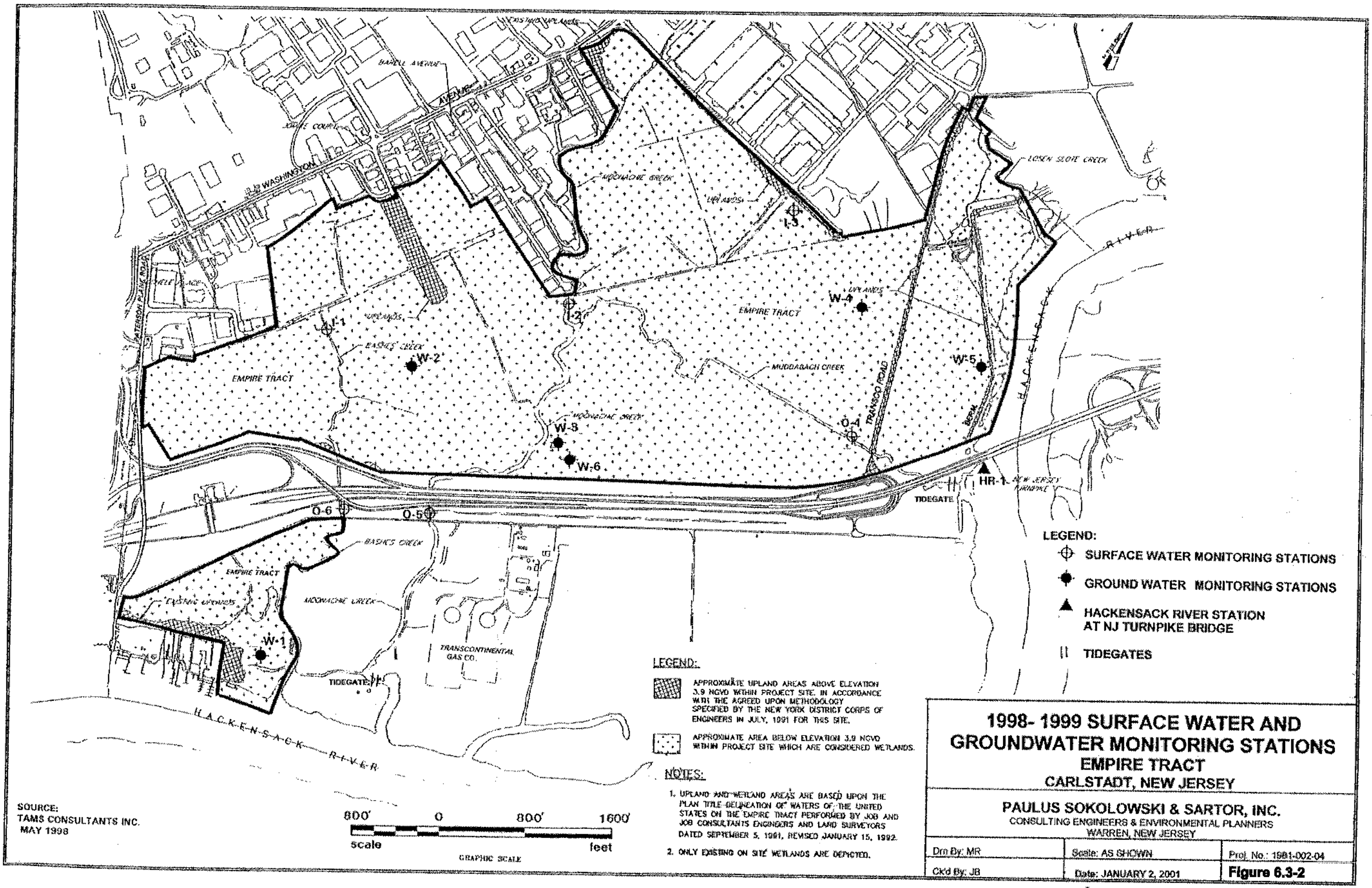
Surface Water Monitoring Program for 1998, 1999, and 2000

The applicant conducted additional water quality monitoring of surface water and groundwater in 1998 and 1999 (PS&S 2000). The objective was to collect sufficient water quality data to estimate the water quality functions of existing wetlands on the Empire Tract, since wetlands can act to filter out contaminants and improve water quality (see Sections 6.3 and 7.3). Data were collected beginning in September 1998 at a series of six monitoring wells installed at the Empire Tract (Figure 6.3-2). In addition, surface water quality and water elevations were monitored at three inflow locations and three outflow locations located at the Empire Tract (Figure 6.3-2) in order to compare concentrations of water quality parameters in surface water entering and leaving the Empire Tract. A summary of the low flow and high flow events sampled during the Surface Water Monitoring Program in 1998 and 1999 is presented in Table 6.3-5. Additional sampling was performed in the Fall of 2000 as noted in Sections 6.1 and 6.2.

6.3.3.2 Empire Tract Water Quality Data Summary

Results of water quality studies of creeks on the Empire Tract indicate that the range of concentrations of several parameters such as pH, BOD, and turbidity were similar among all stations, regardless of whether they were tidally influenced. Other parameters such as salinity and fecal coliform exhibited a slightly higher range within the river, and the sampling stations influenced by the river, when compared to midstream and upstream locations (M2 and M3) on Moonachie Creek (Table 6.3-4). Review of the data presented in Table 6.3-4 indicates that overall water quality as measured by these parameters is comparable or slightly better in creeks on the Empire Tract (or immediately up/downstream) as compared to the Hackensack River station.

The following is a brief summary of results of the above studies, adapted from TAMS (1998) and PS&S (2000), with emphasis on selected parameters pertinent to the principal water quality concerns (salinity, DO, total and fecal coliform, and metals) relevant to the proposed development.



WASHINGTON
AVENUE
BARELL AVENUE
PATERSON PLANK ROAD
MOONACHIE CREEK
UPLANDS
LOSEN SLOTE CREEK
RIVER
EMPIRE TRACT
BASHES CREEK
MUDDABACH CREEK
TRANSCO ROAD
BERM
HACKENSACK
I-1
I-2
I-3
W-1
W-2
W-3
W-4
W-5
W-6
O-4
O-5
O-6
HR-1
NEW JERSEY TURNPIKE
TIDEGATE
TRANSCONTINENTAL GAS CO.
EXISTING UPLANDS
H-A-C-K-E-N-S-A-C-K R-I-V-E-R
LEGEND:
SURFACE WATER MONITORING STATIONS
GROUND WATER MONITORING STATIONS
HACKENSACK RIVER STATION AT NJ TURNPIKE BRIDGE
TIDEGATES
LEGEND:
APPROXIMATE UPLAND AREAS ABOVE ELEVATION 3.9 NGVD WITHIN PROJECT SITE. IN ACCORDANCE WITH THE AGREED UPON METHODOLOGY SPECIFIED BY THE NEW YORK DISTRICT CORPS OF ENGINEERS IN JULY, 1991 FOR THIS SITE.
APPROXIMATE AREA BELOW ELEVATION 3.9 NGVD WITHIN PROJECT SITE WHICH ARE CONSIDERED WETLANDS.
NOTES:
1. UPLAND AND WETLAND AREAS ARE BASED UPON THE PLAN TITLE DELINEATION OF WATERS OF THE UNITED STATES ON THE EMPIRE TRACT PERFORMED BY JOB AND JOB CONSULTANTS ENGINEERS AND LAND SURVEYORS DATED SEPTEMBER 5, 1991, REVISED JANUARY 15, 1992.
2. ONLY EXISTING ON SITE WETLANDS ARE DEPICTED.
SOURCE:
TAMS CONSULTANTS INC.
MAY 1998
800' 0 800' 1600'
scale feet
GRAPHIC SCALE
1998- 1999 SURFACE WATER AND GROUNDWATER MONITORING STATIONS
EMPIRE TRACT
CARLSTADT, NEW JERSEY
PAULUS SOKOLOWSKI & SARTOR, INC.
CONSULTING ENGINEERS & ENVIRONMENTAL PLANNERS
WARREN, NEW JERSEY
Drn By: MR
Ck'd By: JB
Scale: AS SHOWN
Date: JANUARY 2, 2001
Proj. No.: 1981-002-04
Figure 6.3-2

Salinity

Salinity is a major determinant of what species of aquatic biota are likely to inhabit an area within an estuary (Mitsch and Gosselink 1993; Kennish 1992). Salinity data collected from several studies conducted at the Empire Tract (PS&S 2000) indicate that surface water would be classified as freshwater over much of the site under normal conditions, but that the eastern portion of the site located closer to the Hackensack River would be considered brackish.

As discussed in Section 6.3.1.3, freshwater is defined by New Jersey regulations as having a salinity value less than or equal to 3.5 ppt. Based upon regulatory definitions, freshwater areas at the Empire Tract would be classified by NJDEP as "FW-2 NT" (non-trout) waters, and the brackish areas would be classified as "SE-2". Designated uses for FW-2 NT waters include the same uses as for SE-2 waters, but also would include primary contact recreation, and industrial and agricultural water supply as potential uses.

Under normal circumstances the system of tidal gates and berms limits tidal flow from the Hackensack River from entering all but 22 acres of the Empire Tract located east of the New Jersey Turnpike along the Hackensack River. As a result, surface water quality is expected to be influenced primarily by point and non-point discharges originating in the Bashes Creek and Moonachie Creek drainage basins within the Borough of Carlstadt.

While the berms and tide gates usually prevent river water intrusion, it still allows storm runoff entering the site from upland areas to be discharged through the creeks on the Empire Tract to the Hackensack River. However, water will discharge from the creeks on site to the river only when river levels are sufficiently low. Because of this, Moonachie, Bashes, and Muddabach creeks are relatively stagnant. Velocities in the creeks are generally less than 1 ft/sec and water depths are less than 2 ft during most periods sampled (PS&S 2000).

Salinity measurements within creeks and ditches at the Empire Tract indicate freshwater conditions over much of the northern and western portions of the site, with waters becoming more brackish approaching the Hackensack River. The salinity of the groundwater and surface water influences the distribution of different wetland types on the Empire Tract (Section 6.2, Figure 6.2-3).

Average annual salinity values measured by NJMC (then HMDC) from 1978 to 1988 at Station 13 on Moonachie Creek ranged from 0.9 to 8.7 ppt, indicating both fresh and brackish/saline conditions in the creek at various times. This salinity range is similar to that reported from nearby Station 3 in the Hackensack River for the period from 1995 to 1997 (Table 6.3-2). The variations in salinity may be attributed to precipitation events and malfunctioning tide gates that periodically allow river water to enter the Empire Tract. While groundwater seepage from the river could also occur, this is less likely since a thick clay layer underlies the Meadowmat layer on the site (see Sections 6.1 and 6.12). It is possible that there is some shallow groundwater exchange between the river and the wetlands immediately adjacent to it, but data collected do not support a finding of extensive tidal influence on groundwater (see Sections 6.1, 6.12 and 6.13).

Table 6.3-4
Water Quality Results for the Empire Tract and Adjacent Hackensack River (ERM/GES 1984 Data)

Parameter	Unit	NJ Surface Water Criteria	Hackensack River (Station HR)	Bashes Creek – Downstream (Station B1)	Moonachie Creek-Upstream and Midstream (Stations M2, M3)	Moonachie Creek-Downstream (Station M1)	Muddabach Creek-Downstream (Station LM)
Class	--	--	SE2	SE2	FW2	SE2	SE2
Salinity	ppt	□3.5 (FW2) >3.5 (SE2)	4.0-9.2	2.5-7.2	<1-5.9	2.5-6.7	3.5-8.8
pH	--	6.5-8.5	6.8-7.2	6.7-7.8	6.6-8.9	6.8-7.8	6.9-7.3
DO	mg/L	4.0 (min)	2.8-6.4	4.8-11.3	3.0-14.8	4.1-15.5	2.6-7.8
BOD_5	mg/L	25 (A)	7-15	6-17	4-22	7-18	8-16
TSS	mg/L	40	10-32	15-94	10-104	13-60	10-60
Turbidity	NTU	50 (FW2) 30 (SE2)	7-9	8-25	11-38	9-25	8-12
Fecal Coliform	#/100mL	200(FW2) 770(SE2)	100-4,900	<100-800	<100-3,200	<100-500	100-2,200
Total Coliform	#/100mL	5,000 (A)	2,000->80,000	1,900-19,000	2,000-110,000	1,000->80,000	2,000->80,000
Phosphate	mg/L	30 (A,c) 0.1 (USEPA CCC*)	2.0-5.1	1.1-2.4	0.4-5.8	1.1-2.3	2.3-5.1
Total Nitrogen	mg/L	30 (A)	2-10	3-6	<1-6	<1-8	3-8
Cadmium	ug/L	10 (FW2) 9.3 (USEPA CCC)	NA	NA	NA	NA	NA
Chromium	ug/L	0.16 (FW2) 3.,230 SE2)	NA	NA	NA-2.05	NA	NA
Copper	ug/L	2.9 (USEPA CCC)	NA	NA	NA	NA	NA
Lead	ug/L	3.5 (FW-2) 8.5 (USEPA CCC)	NA	NA	NA	NA	NA
Nickel	ug/L	3,900 (SE-2)	NA	NA	NA	NA	NA

Note: A. NJMC discharge limitation from ERM/GES 1985; NJ surface water standard not established.
B. USEPA continuous concentration criterion (CCC) for saltwater.
C. USEPA CCC of 0.1 ug/L for marine waters is for total elemental phosphorus, not phosphate, so results are not directly comparable.
NA- Data not available.
Source: Data from ERM/GES 1985, NJ Surface Water Criteria from NJAC 7:9B-1.14, and USEPA Ambient Water Quality Criteria (1992).

Salinity measurements taken by ERM/GES in 1984 in Moonachie Creek near the upstream border of the Empire Tract at Commerce Boulevard indicated freshwater conditions that varied with precipitation. Ten readings collected were <1 ppt, while the other two readings were 2.8 ppt and 3.2 ppt, respectively. Conditions were slightly more brackish at the midstream station near Barell Avenue (Station M2), with salinities ranging from less than 1 to 5.9 ppt. The average value at that location of 2.7 ppt was still less than the NJDEP criterion (3.5 ppt) for an estuarine system. At the Moonachie Creek downstream station near the downstream side of the New Jersey Turnpike culvert (Station M1), higher salinity values ranging from 2.5 to 6.7 ppt were reported. These results are consistent with the NJMC data from 1978 to 1988, and indicate estuarine conditions.

The downstream stations on Bashes Creek and Muddabach Creek (e.g., B1, LM) also exhibited higher salinity values (2.5 to 7.2 ppt) than the upstream stations on Moonachie Creek (<1 to 3.2 ppt), and varied little with precipitation. The salinity values in the lower portion of these creeks were similar to values measured at the Hackensack River station.

Based on the 1984 salinity data, the NJDEP FW-2 water quality classification as "freshwater" would be applicable to the Moonachie Creek upstream station. For the downstream station on Moonachie Creek, as well as the Bashes Creek and Muddabach Creek stations, the 1984 data suggest these waters would be classified by NJDEP as SE-2 waters. The midstream station exhibits variable salinity, with some values exceeding the 3.5 ppt NJDEP criterion defining estuarine waters. Hence, this location is probably close to the upgradient extent of SE-2 waters under normal circumstances.

The 1991 data collected by TAMS indicated similar trends. Salinity measurements were less than 1 ppt in Moonachie Creek at the upstream boundary of the Empire Tract and in the creek down to its confluence with Muddabach Creek. Salinity was also less than 0.5 ppt in ditches at the western perimeter of the Empire Tract, which receives runoff from off-site areas in the Bashes Creek and Moonachie Creek basins. Salinity values in the creeks near the New Jersey Turnpike and closer to the Hackensack River were higher, suggesting that the tide gates on Moonachie and Muddabach Creeks allowed brackish river water to enter the Empire Tract.

Continuing this trend, the 1998-99 monitoring by PS&S showed that in the tidally influenced portion of Bashes Creek (Station O6) between the New Jersey Turnpike and the river, salinity values ranged from 0.6 to 10.0 ppt. In Moonachie Creek (Station O5) near the New Jersey Turnpike, salinity values ranged from 0.2 to 13.0 ppt. In Muddabach Creek (Station O4) near the New Jersey Turnpike and the on-site Transco road, salinity values ranged from less than 0.3 to approximately 11.0 ppt.

Dissolved Oxygen

Dissolved oxygen concentrations were measured by NJMC (then HMDC) from 1978 to 1988 at Station 13 on Moonachie Creek just downstream of the New Jersey Turnpike. Concentrations ranged from 0.1 mg/L to 15 mg/L. Annual average concentrations during this period ranged from 2.5 to 7.8 mg/L. Many of the instantaneous DO measurements were below the NJDEP SE-2 standard of 4 mg/L. The low levels of DO were attributed to the lack of flushing in the creek (TAMS 1997). Monitoring at this NJMC station was discontinued in 1988.

In 1984, ERM/GES measured DO concentrations in Moonachie Creek at the upstream and midstream stations, as well as the Muddabach Creek station. Concentrations fell below the 4 mg/L NJDEP standard on at least two occasions. The observed DO concentrations below 4 mg/L were attributed to the fact that those measurements were taken following the overnight period when increased oxygen utilization occurs due to algae respiration (TAMS 1998). DO concentrations in the creeks were generally greater than concentrations in the river, suggesting that the Empire Tract may export DO to the river (ERM/GES 1985). This finding is consistent with conclusions of the BCUA modeling study (CBA 1990), which concluded that marshes in the HMD act to improve DO concentrations in the Hackensack River.

Comparison of upstream and midstream stations M2 and M3 on Moonachie Creek with the downstream location M1 indicate that the range of DO concentrations is similar between these locations. In contrast, the range of DO concentrations recorded in the Hackensack River was lower.

Additional DO measurements were collected by TAMS in 1996. Concentrations were well above the required minimum concentration of 4 mg/L. However, these measurements were made during a runoff event in the early spring, when DO effects would be expected to be higher.

Fecal and Total Coliform Bacteria

Fecal coliform levels were measured on the Empire Tract in 1984 during the ERM/GES investigation. Results (Table 6.3-4) suggest that surface waters on-site are occasionally impacted by fecal and total coliform levels likely originating in upstream storm water runoff. Fecal bacteria are often associated with small suspended particles of organic matter in the water column. Because tidal gates reduce or eliminate the inflow of river water under normal circumstances, and outflows from the creeks to the river occur only when the water elevation on site is higher than that of the river, the water in the creeks moves slowly. Due to the reduced flow of the creeks on the Empire Tract, some fecal bacteria and organic material can be expected to settle out into the sediment, preventing further migration to the river.

Fecal coliform levels at the Moonachie Creek upstream and midstream stations exceeded the FW-2 NT standard, whereas the more brackish Moonachie Creek downstream station did not exceed the SE-2 standard (Table 6.3-4). Fecal coliform levels in the other creeks on the Empire Tract exceeded the SE-2 standard. The source of coliforms in the on-site creeks is most likely storm water runoff from upstream, developed portions of the watershed. This explanation is supported by the fact that coliform levels were generally higher following rain events. Also, total coliform levels were generally greater at the upstream and midstream stations on Moonachie Creek than the downstream station. The upstream stations are located closer to outfalls that carry storm water into these creeks from off site.

Metals and Other Inorganic Compounds

Selected heavy metals, including cadmium, chromium, copper, lead, mercury, nickel, and zinc were analyzed in surface water and sediment in the on-site creeks during the 1984 ERM/GES investigation. Results of this study indicated that four of the metals, cadmium, copper, lead, and nickel, were not detected in the surface water samples (Table 6.3-4). Mercury was only detected off site in Losen Slote water at a concentration of 4 micrograms per liter (μg/L). Chromium was detected in 10 of the 12 surface water samples at the Moonachie Creek midstream station near the terminus of Barell Avenue, at concentrations ranging from 70 to 2,050 μg/L. Some of these sample concentrations exceeded the NJDEP FW-2 NT standard of 160 μg/L. Exceedances were detected only at location M2, shown on Figure 6.3-1. The 12 samples collected at M2 exceeded the NJDEP FW-2 standard of 160 μg/L. The concentrations exceeding the criterion were 200 μg/L, 270 μg/L, 300 μg/L, 400 μg/L, and 2,050 μg/L. Chromium was also detected in one of 12 surface water samples collected at the Moonachie Creek upstream station at a concentration of 60 μg/L. Chromium was not detected at the other stations (50 μg/L detection limit). Concentrations of zinc in the on-site creeks ranged from 10 to 80 μg/L, but did not exceed the 86 μg/L USEPA saltwater Criterion for Continuous Concentration (CCC).

The range of total nitrogen concentrations recorded was slightly higher at the downstream location (M1) on Moonachie Creek and in the Hackensack River, relative to upstream and midstream locations.

The concentrations of metals detected on the Empire Tract and surrounding waters are indicative of the regional urbanized environment, and although some metals exceeded NJDEP water quality standards, the results should not be considered unique to the site. The sources of metals include storm water runoff and possibly industrial wastewater discharges. Metals dissolved in the water column can affect fish, and metals in sediment can affect other aquatic life such as benthic invertebrates (see Section 6.3.3.5). A portion of the metals in the water column would be expected to adsorb to suspended matter and eventually settle into the river or stream bed sediment. Once in the sediment they may adsorb to the roots of common reed plants or other vegetation growing within the sediment, and in some cases be taken up by the plants themselves. Metals present in the water column that do not settle out would be expected to eventually be transported into the Hackensack River.

Additional monitoring efforts were conducted in 1998 and 1999 (PS&S 2000) at the request of USACE as a follow-up and confirmation to earlier studies. Sampling locations are shown in Figure 6.3-1. Inflow stations are those located in creeks or near outfalls leading onto the Empire Tract. Outflow locations are located where the creeks leave the Empire Tract. The outflow concentrations are higher than inflow concentrations for several parameters. This may be due to leaking tide gates allowing Hackensack River water to enter the site creeks, since concentrations of several parameters are higher in the river. Table 6.3-5 provides a summary of the surface water analytical results for both high and low flow events that were sampled quarterly. The high flow events clearly show a marked decrease in TSS between the inflow and outflow stations. This is due to the settling of material as the flow moves slowly across the site.

Table 6-3.5
Summary of Low Flow and High Flow Surface Water Quality Analyses 1998-1999
Empire Tract, Carlstadt, New Jersey

Parameter	Inflow Stations I-1, I-2, & I-3		Outflow Stations O-4, O-5 & O-6	
	Low Flow Average / Range	High Flow Average / Range	Low Flow Average / Range	High Flow Average / Range
Biochemical Oxygen Demand, 20 Day	41.97	34.85	54.96	44.44
	15.7-67	4.5-84.7	20-150	5.8-112
Chemical Oxygen Demand	70.50	70.44	100.37	76.23
	19-160	7.3-200	16-180	33-230
Chromium	--	--	--	--
	ND-0.014	ND-0.035	ND-0.013	ND-0.017
Phosphorus (Total)	0.25	0.22	0.55	0.24
	0.028-0.659	0.081-0.862	0.061-3.64	0.108-0.45
Total Kjeldahl Nitrogen	6.42	3.55	7.44	3.99
	1.18-12	1.17-5.37	1.18-14.2	1.76-10.3
Nitrate- N	0.40	0.57	0.66	0.69
	0.12-1.12	0.11-1.29	0.2-3.2	0.08-1.54
Ammonia- N	1.06	.58	1.41	1.06
	0.15-2.96	0.15-1.18	0-6.59	0.22-3.09
Total Organic Carbon (mg/kg)	27.11	20.37	24.37	23.62
	6.4-46.5	6.1-59.4	8.3-80.6	3.3-54.6
Total Petroleum Hydrocarbons	--	--	--	ND
	ND-2.5	ND-1.8	ND-1	ND
Total Suspended Solids	48.26	44.01	50.77	31.64
	6.4-180	6.4-250	19-180	5.2-69
Turbidity (NTU)	37.44	43.11	18.29	28.24
	4.9-134	0.0503-251	1.2-44	0.019-69
Conductivity (umhos/cm)	6717.47	1896.67	15661.67	3665.00
	594-19000	60-16770	6340-21000	70-12650
Salinity (ppt)	5.11	0.88	11.02	1.88
	0.3-11	0-5.6	8.6-13	0.2-7.3
Dissolved Oxygen	4.53	3.43	3.87	3.34
	0.27-11	0.97-7.7	0.38-11.5	1.4-6
Temperature (°C)	18.62	18.84	18.82	18.96
	7.7-34.1	14.1-21.7	8-32.8	14.8-23.7

All units in mg/l unless otherwise noted.
ND- Non-detected
Source: *PS&S 2000 Surface Water Monitoring Program)*

6.3.3.3 *Storm Water Quality Entering the Empire Tract*

Both surface water and sediment in creeks on the Empire Tract are influenced by the long-term cumulative effects of storm water runoff entering the site. Table 6.3-6 summarizes concentrations of representative water quality parameters measured in storm water by TAMS in 1996 at five locations. Review of the data indicates that fecal coliform bacteria, chromium, lead, and zinc are present in runoff entering the site. The concentrations of these parameters present are typical for urban runoff, as compared to median values measured under the National Urban Runoff Program (NURP) on Long Island (LIRPB, 1982). For example, the chromium concentration in Moonachie Creek upstream of the Empire Tract was an estimated 7.8 µg/L, compared with median values in urban runoff measured in the NURP study ranging from 2 to 16 µg/L, depending upon location. The lead concentration in Moonachie Creek upstream of the site was 37 µg/L, and exceeded NJDEP FW-2 criterion of 3.5 µg/L. Median concentrations measured under the NURP study ranged from 2 to 275 µg/L, depending upon location. Zinc concentrations were not measured under the NURP study. However, fecal coliform bacteria present in Moonachie Creek are considerably less than those measured in urban runoff on Long Island in another NURP study (LIRPB 1982). While the NURP data were not collected from the same watershed, they can be considered representative of typical urban runoff since land use patterns between the two watersheds are similar.

Follow-up studies conducted in 1998 and 1999 (Table 6.3-5) indicate that several metals and chemical compounds including chromium, phosphorus, nitrates, and others were detected in creek water entering the site from upstream in the watershed. The concentrations are typical of those recorded elsewhere in urban runoff (Table 6.3-6).

Table 6.3-6
Water Quality of Storm Water Drainage Entering the Empire Tract (TAMS 1996 Data)

Parameter	**Unit**	**NJ Surface Water Criteria (FW2)**	**Concentration in Moonachie Creek- Upstream of Site (Station 1)**	**Range of Concentrations in Outfalls/Ditches (Stations 2-5)**	**Range of Typical Concentrations in Urban Runoff Nationwide (USEPA, 1992)**	**Range of Median Concentrations in Long Island Urban Runoff (NURP); (LIRPB, 1982)**
pH	--	6.5-8.5	7.2	6.5-7.2	NR	NR
Conductivity	μmho/cm	--	205	100-210	NR	NR
Turbidity	NTU	50	119	6.0-56	NR	0.9-27
DO	mg/L	4.0 (min)	11.4	9.4-14.4	NR	50 (one location measured)
Fecal Coliform	#/100mL	200	100	32-756	NR	3.0-9300
Total Coliform	#/100mL	5,000 (A)	430	320-2,600	NR	3.0-24,000
BOD	mg/L	25 (A)	<3	<3	NR	1.0-10
COD	mg/L	--	57	19-59	NR	NR
Ammonia-Nitrogen	mg/L	--	<0.05	<0.05-0.068	NR	0-1.35
Total Suspended Solids	mg/L	40	56	13-59	NR	NR
Chromium	μg/L	160	7.8(B)	3.4(B)-61.4	1-100	2.0-16
Lead	μg/L	3.5	37.0	9.6-22.6	6-460	2.0-275
Zinc	μg/L	--	106	<3.3-13.6(B)	10-240	NR

Notes: A. NJMC discharge limitation from ERM/GES 1985; NJ surface water standard not established.
B. B=estimated concentration (inorganics).
C. NR = not reported
Source: TAMS 1996 and NJAC 7:9B-1.14.

6.3.3.4 Groundwater

Limited groundwater quality studies have been conducted on the Empire Tract, because the groundwater below the site is not used, nor is it intended to be used, as a potable source. Moreover, there are no documented historical uses of the site that would require groundwater monitoring for contaminants. According to NJDEP Groundwater Quality Standards (N.J.A.C. 7:9-6), all groundwaters in the State are classified as Class II-A groundwaters, unless otherwise specified. However, assuming salinity concentrations to be comparable to chloride and total dissolved solids (TDS) concentrations, at least portions of the groundwater at the site could potentially be classified as Class III-B groundwater. Class III-B groundwater consists of water exhibiting natural concentrations of chloride exceeding 3,000 mg/L or TDS above 5,000 mg/L. Designated uses of Class III-B groundwaters include any reasonable use(s) other than potable water.

The groundwater quality of the Empire Tract is primarily of interest from the perspective of its interaction with surface water, and the role the emergent wetlands play in providing improvements to the quality of water in the creeks. Shallow groundwater within the wetlands has been measured to have saline conditions similar to the low range of brackish conditions measured in the Hackensack River (PS&S 2000). Salinity in the groundwater is due to several factors including historical tidal flooding of the site, extreme tidal events which flood the site from the river by overtopping the existing berms, and river water entering the creeks from the leaking tide gates. Studies of the creeks and wetlands on the Empire Tract indicate that exchange between the wetland groundwater and creek waters can occur under certain conditions (see Sections 6.1, 6.12 and 6.13). Therefore, the wetlands on the Empire Tract may act to provide treatment of water from the Hackensack River during certain periods of the year when there is sufficient hydraulic gradient for the creek water to move laterally through the creek banks into the adjacent wetlands.

In contrast, evaluation of the available hydrological data indicates there is little *direct* interaction between groundwater and Hackensack River water on the Empire Tract, except in the immediate vicinity of the river (see Section 6.13). Groundwater elevations at the site are known to fluctuate due to seasonal variations in precipitation and runoff, temperature, and tides (TAMS 1998). However, the magnitude of these fluctuations measured suggests that there is little tidal influence on the groundwater of the site.

6.3.3.5 Empire Tract Sediment Quality Data Summary

Sediment is the soil and organic matter that settles in a loose form on the bottom of a water body. It provides a substrate for benthic macroinvertebrates, rooted aquatic plants and other aquatic life. Sediment quality reflects the historical deposition of contaminants that may have entered the water body from overland runoff, groundwater contamination or, in some cases, aerial deposition. The quality of sediment under water bodies on the Empire Tract is relevant from the perspective of the wetlands mitigation plan, since sediment must be disturbed during construction. If highly contaminated sediments were present, earth-moving activities could exacerbate mortality to aquatic life by introducing contaminants into the water column where they would become more available for uptake. Sediment quality is also relevant as an indicator of the amount of urban runoff received by the on-site wetlands, and provides an indicator of the function that existing wetlands and mudflat areas may perform in inhibiting contaminant transport into the Hackensack River.

The metals data from sediment collected in 1984 from the creeks on the Empire Tract are summarized in Table 6.3-7. Results were compared to guidelines provided by Long et al. (1995b), used by NJDEP and other agencies to evaluate sediment quality. The effects range-low (ER-L) and effects range-median (ER-M) values are literature-based guidelines derived from prior studies in which organisms were exposed to sediment in order to measure biological effects. The ER-L value refers to the concentration below which no adverse effects were observed in populations of organisms exposed to a concentration of the given parameter. The ER-M value represents the midpoint concentration where effects were observed of all studies conducted on the particular parameter. If the concentration measured in the sediment is less than the ER-L, toxic effects to aquatic life are unlikely. In cases where the ER-M is exceeded, toxicity or adverse effects may be occurring to aquatic biota exposed to the sediment. Sediment concentrations between the ER-L and ER-M are common in the New York-New Jersey Harbor region (Long et al. 1995a), and are potentially toxic to aquatic life.

As listed in Table 6.3-7, chromium and mercury were the only parameters for which the ER-M guidelines were exceeded in certain samples. The highest chromium concentration measured was one sample at 768 mg/kg in Bashes Creek and the lowest sample measured 65.3 mg/kg, compared to the ER-M guideline of 370 mg/kg. Samples in Moonachie Creek and Muddabach Creek did not measure chromium above 160 mg/kg. Although some sediment samples were measured above a concentration that could potentially affect aquatic life, the majority of samples suggest chromium levels below the ER-M guideline. Chromium uptake was measured at a similar study site in the Hackensack Meadowlands (diked estuarine marsh with restricted tidal flow) by Hall and Pulliam (1995). The authors reported that although chromium was detected in sediment at levels up to 1,760 mg/kg, it was not detected in tissues of aquatic biota at levels significantly higher than those detected at a reference site where chromium levels in sediment ranged from 33 to 180 mg/kg. Several exposure routes were investigated, and the authors concluded that tissue uptake by blue crabs, killifish, and common reed were not significant enough to pose ecological risks. The range of sediment concentrations in that study were higher (153 to 1,760 mg/kg) than that reported on the Empire Tract (14.3 to 768 mg/kg).

Mercury was detected in Bashes Creek at a maximum concentration of 1.4 mg/kg, compared to the ER-M value of 0.71 mg/kg. Mercury pollution is widespread in the New York-New Jersey Harbor estuary (Long et al. 1995b), and is an acute problem in Berry's Creek, about 1 mile south of the Empire Tract (Weis et al. 1986). Long et al. (1995b) reported a mercury concentration of 4.29 mg/kg at Station 14 in the lower Hackensack River near Berry's Creek in 1993, and a concentration of 0.665 mg/kg in the Hackensack River near the mouth of Berry's Creek Canal.

Other metals were detected in sediment from Empire Tract creeks at levels exceeding the ER-L, but not ER-M. In Bashes Creek at the sampling station downstream of the Empire Tract, these metals included chromium, copper, lead, nickel and zinc (Table 6.3-6). The concentrations detected reflect the degraded regional water quality of the lower Hackensack River and Newark Bay, because the location these samples were collected from is tidally influenced.

In Moonachie Creek, metals exceeding the ER-L included cadmium, chromium, copper, lead, mercury, nickel, and zinc; these exceedances are indicative of the quality of the urban storm water entering the site. No metals analyzed exceeded the ER-L in Muddabach Creek at the downstream location. Concentrations of chromium, copper, and lead reported from these locations (Table 6.3-7) are similar to those reported in the Hall and Pulliam (1995) study. In that study, concentrations measured in eight sediment samples collected at a reference location in the HMD ranged from 33 to 180 mg/kg chromium, 17 to 102 mg/kg copper, and 24.6 to 122 mg/kg lead. Mercury was not analyzed in sediment in the Hall and Pulliam study.

Collectively the data suggest that sediment quality on the Empire Tract is impacted by off-site urban runoff at levels similar to sediment elsewhere in the HMD, whereas tidal portions of the site are most likely influenced by the water quality of the Hackensack River. Furthermore, the site creeks may act to attenuate the transport of sediment into the Hackensack River by allowing particles to settle out before they reach the tidal gates in suspension. Should the creeks ever overflow their banks (although this is believed to occur infrequently), the opportunity would exist for wetlands to improve the water quality of the system by absorbing the metals to the roots or peat layer of the common reed.

Table 6.3-7
Empire Tract Sediment Quality - Metals Concentrations (ERM/GES 1984 Data)

Parameter	Unit	Long et al. (1995b) Effects Range-Low (ER-L)	Long et al. (1995b) Effects Range-Median (ER-M)	Bashes Creek - Downstream (Station B1)	Moonachie Creek - (All Stations: M1,M2,M3)	Muddabach Creek - Downstream (Station LM)
Cadmium	mg/kg	1.2	9.6	<0.5	<0.5-1.4	<0.5
Chromium	mg/kg	81	370	65.3-768.0	30.5-160.0	14.3-17.2
Copper	mg/kg	34	270	18.7-66.6	11.0-60.8	2.9-7.4
Iron	%	NA	NA	2.06-4.92	0.76-6.76	0.67-2.18
Lead	mg/kg	46.7	218	21.8-129.0	20.2-124.0	<0.5-1.9
Mercury	mg/kg	0.15	0.71	<0.1-1.4	0.2-0.7	<0.1
Nickel	mg/kg	20.9	51.6	21.8-47.8	9.1-40.5	3.8-7.4
Zinc	mg/kg	150	410	70.4-165	67.3-227.0	12.4-21.2

Notes: A. NA=Data not available.
B. Sediment core depths: 0-2 inches and 6-8 inches.

Source: Data from ERM/GES 1985; ER-L and ER-M values from Long et al., 1995b.

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6.4 FISH AND SHELLFISH

6.4.1 Regional Setting

This section provides an overview of the fish and shellfish habitat within the lower Hackensack River, immediately adjacent to the Empire Tract. Specific habitat descriptions are also provided for each of the 14 species of fish that have been documented within the immediate vicinity of the Empire Tract.

6.4.1.1 Regional Fish Communities

The Hackensack River and the marshes in the Meadowlands regularly support 34 species of fish (USEPA and USACE 1995). Since the salinity of the lower Hackensack River is quite variable, a variety of fish are present, including freshwater, estuarine, marine, and anadromous fish species (Figure 6.4-1). (Anadromous fish are those, which spend most of their life at sea, but return to freshwater to spawn).

Many of the fish species common in the lower Hackensack River are estuarine species that tolerate broad ranges in salinity. Further downstream in Newark Bay, fish communities occupying deeper waters are dominated by more marine species with higher salinity tolerances (Will and Houston 1992). Since the lower Hackensack River is characterized by elevated concentrations of contaminants in sediment and low dissolved oxygen in the summer months, the dominant fish species are those, which are also tolerant of fluctuations in water quality (USEPA and USACE 1995).

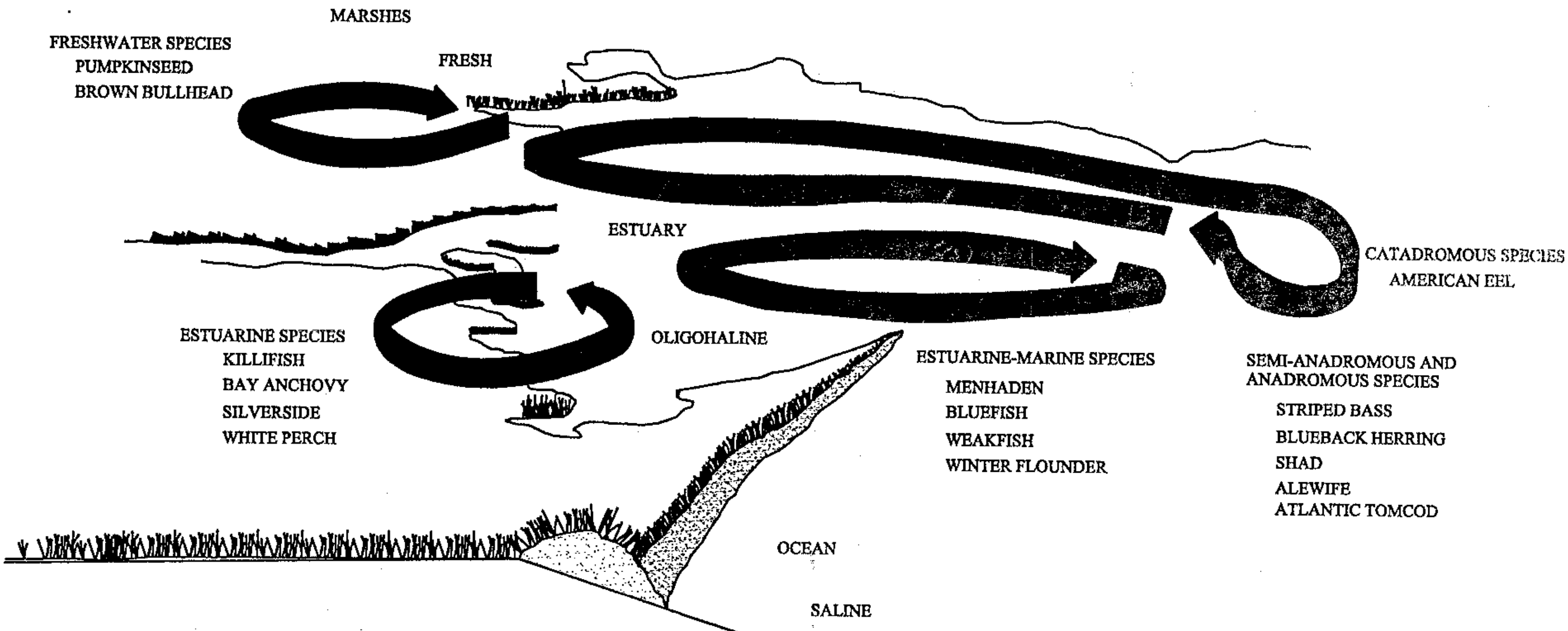
Several fish species are continuously present in the river ("resident species"), while others are present only during certain periods, such as the spring, when they use the river to spawn. Among resident species in the river, the most abundant fish within the vicinity of the Meadowlands is the mummichog (*Fundulus heteroclitus*) (USEPA and USACE 1995). This species is a small estuarine fish about 3 to 4 inches long that inhabits shallow water areas and can tolerate a broad range of salinities (Smith 1985). Other common resident species of fish include striped killifish (*Fundulus majalis*), inland silverside (*Menidia beryllina*), Atlantic silverside (*Menidia menidia*), white perch (*Morone americana*), brown bullhead (*Ameuirus nebulosus*), white catfish (*Ameuirus catus*), common carp (*Cyprinus carpio*), pumpkinseed sunfish (*Lepomis gibbosus*), bay anchovy (*Anchoa mitchilli*), and the American eel (*Anguilla rostrata*) (USEPA and USACE 1995).

Several anadromous species use the Hackensack River and tidal marshes to spawn in the spring. These include alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), Atlantic tomcod (*Microgadus tomcod*), and striped bass (*Morone saxatilis*). These are ocean-living species that migrate into freshwater rivers to spawn during the spring; the juvenile fish also live within the river and adjacent tidal marshes. Some marine species such as the Atlantic menhaden (*Brevoortia tyrannus*) and bluefish (*Pomatomus saltatrix*) also utilize the river during spring months (USFWS 1997). During summer months these anadromous and marine species are found in lower numbers, or are completely absent from the Hackensack River. They return in the fall, along with weakfish (*Cynoscion regalis*) and winter flounder (*Pseudopleuronectes americanus*).

6.4.1.2 Fish Species in the Vicinity of the Empire Tract

Of the 34 species of fish recorded in the lower Hackensack River, 14 have been recorded in the immediate vicinity (0.5 mile) of the Empire Tract (Table 6.4-1). From 1987 to 1988, HMDC, now NJMC, conducted an aquatic inventory study (HMDC, 1989) within the Hackensack River. The inventory included two Hackensack River sampling stations adjacent to the Empire Tract that were referred to as Trap Net 5 (TN 5) and Seine 4 (S4). These locations are shown on Figure 6.4-2. Trap Net 5 was located on the western bank of the river near the mouth of Losen Slote (at the northern extent of the Empire Tract's frontage on the Hackensack River). Seine S4 was located on the western bank of the river just below the New Jersey Turnpike's Western Spur. HMDC (currently NJMC) used two methods of sampling to collect fish from the river at these locations: trap nets (at TN5) and seines (at S4).

Ecology of Fish Species Inhabiting the Tidal Marshes of the Hackensack Meadowlands



FISH AND SHELLFISH THAT USE TIDAL FRESHWATER MARSHES CAN BE CLASSIFIED INTO FOUR GROUPS: FRESHWATER, ESTUARINE, ANADROMOUS AND CATADROMOUS, AND ESTUARINE-MARINE (ADAPTED FROM MITSCH AND GOSSELINK 1986 WITH AUTHOR PERMISSION (1)).

Figure 6.4-1

Biological Sampling Locations

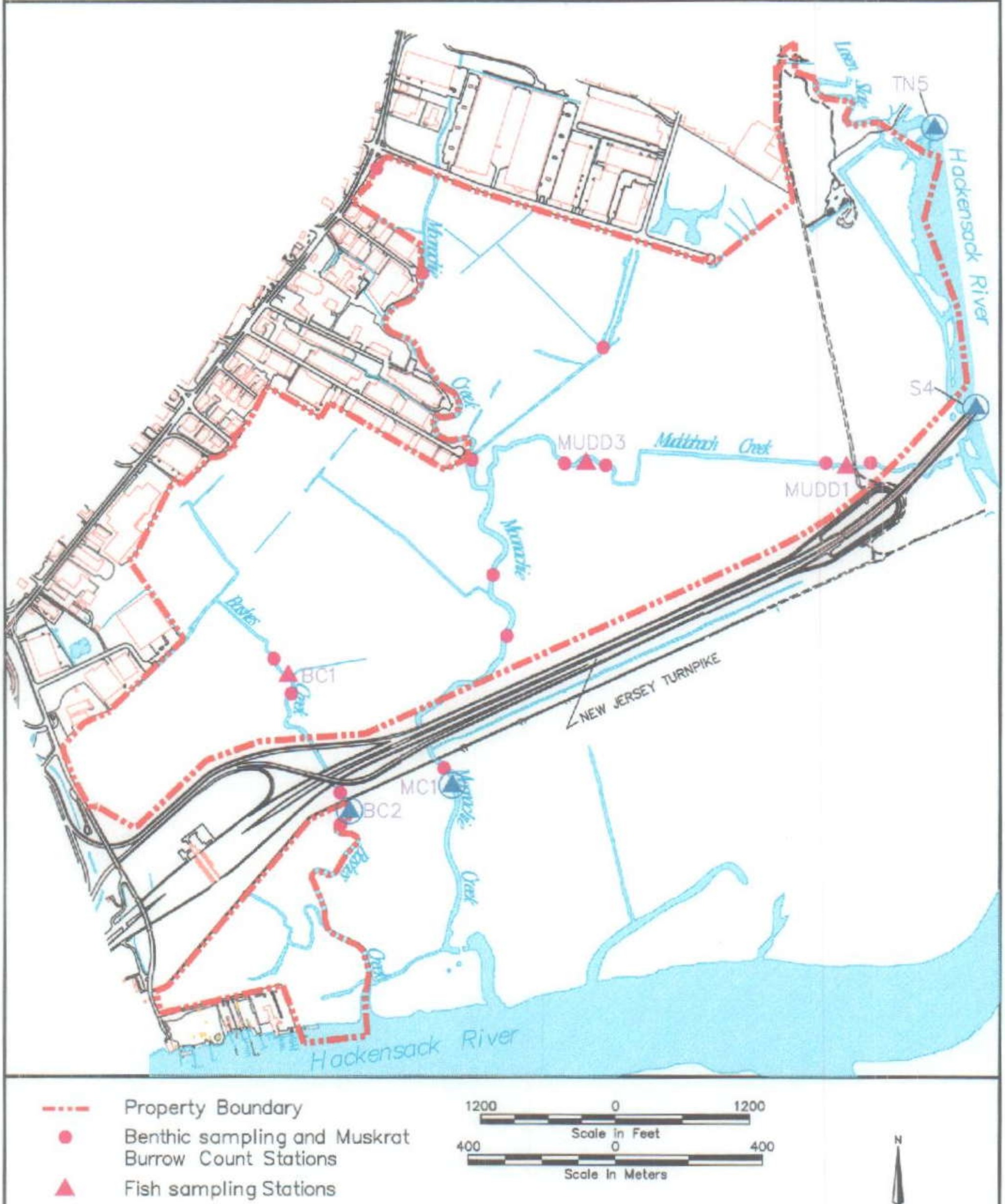


Figure 6.4-2

Table 6.4-1
Fish Collected Off-Site at Hackensack River Stations Adjacent to the Empire Tract

Common Name	Scientific Name	Trap Net	Seine
Alewife	*Alosa pseudoharengus*	□	
Black crappie*	*Pomoxis nigromaculatus*	**N/L**	**N/L**
Blueback herring	*Alosa aestivalis*	□	
Brown bullhead	*Ameiurus nebulosus*	□	
Common Carp	*Cyprinus carpio*	□	
Gizzard shad	*Dorosoma cepedianum*	□	□
Golden shiner*	*Notemigonus crysoleucas*	**N/L**	**N/L**
Inland silverside	*Menidia beryllina*		□
Mummichog	*Fundulus heteroclitus*	□	□
Pumpkinseed	*Lepomis gibbosus*	□	□
Spot	*Leiostomus xanthurus*	□	
Striped killifish	*Fundulus majalis*		□
Weakfish	*Cynoscion regalis*	□	
White perch	*Morone americana*	□	□

*N/L – Not Listed; Species noted by TAMS (1998) as occurring within the Hackensack River, but not listed in their Table 6.4-3, which reported actual sampling results of their field survey.
Source: Based upon HMDC, 1989 as reported by TAMS (1998).

The following is a brief description of the habitat requirements (including spawning) of the 14 species of fish from the Hackensack River that have been recorded in the immediate vicinity of the Empire Tract. Included is a description of their habitat use within the Hackensack River estuary.

Killifish

Killifish include the mummichog (*Fundulus heteroclitus*) and the striped killifish (*Fundulus majalis*). Both are resident species which are common throughout the entire Hackensack River estuary, as they tolerate the broad fluctuations in salinity (Lippson and Lippson 1997), as well as the low levels of dissolved oxygen present in the estuary (USACE and USEPA 1995). The mummichog is, by far, the most abundant of all fish species in the estuary. Prior studies have found that mummichogs account for greater than 90% of the total fish caught in trawls and traps (USFWS 1997).

Various age groups of both species, from newly hatched larvae to adults, live in schools at the edge of the tidal marshes. At low tides, killifish lie near the bottom of creeks, while at high tide they move into marshes to feed opportunistically on whatever food is available (Mitsch and Gosselink 1993). Killifish are permanent residents in the estuary and they have a small home range along the banks of tidal creeks of approximately 30 meters long (Daiber 1982). Killifish spawn during spring and summer months during periods of increasing water temperatures (Able 1990). Spawning sites are diverse and eggs have been observed within silt at the bottom of creeks, within empty shells and other debris, and within tidal marshes on vegetation (such as on the primary leaves of cord grass) (Daiber 1982).

Inland Silverside

The inland silverside (*Menidia beryllina*) is a resident inshore species that is typically observed in association with killifish. It too is a schooling species that moves into tidal marshes at high tide to feed. Like killifish, the inland silverside has a small home range and is a year-round resident of the estuary. The spawning season is from May to July and eggs are deposited on creek bottoms and within tidal marshes (Geiser 1984).

Herring

Two herring species, the alewife (*Alosa pseudoharengus*) and the blueback herring (*Alosa aestivalis*), were collected in the river adjacent to the Empire Tract. These species are anadromous fish that spawn in the open areas of large rivers (Lippson and Lippson 1997). The adults move downstream after spawning in the spring, and by summer most have returned to the ocean. Concurrently, the young hatch and grow rapidly through the spring and summer in the tidal fresh and brackish waters. Tidal marshes serve as major nursery grounds for these species. Juveniles are found in peak abundance in tidal marshes, where they feed on small invertebrates (Mitsch and Gosselink 1993). As they mature, they gradually migrate downstream.

Gizzard Shad

The gizzard shad (*Dorosoma cepedianum*) is a common plant-eating (herbivorous) fish associated primarily with freshwater habitats (Niering 1985). However, it also can behave like an anadromous species. This behavior occurs when individuals spend most of the year downstream in more saline water closer to the mouth of the estuary and migrate upstream to the tidal freshwater portion of the river to spawn. The young then migrate downstream into brackish waters (Lippson and Lippson 1997). The gizzard shad is a prime food item ("forage fish") for larger carnivorous fish (Niering 1985).

White Perch

Like the herring and shad discussed above, the white perch (*Morone americana*) also must seek freshwater to spawn. It is truly an estuarine species that never occurs in the ocean (Lippson and Lippson 1997). It is referred to as "semi-anadromous" as individuals do not migrate all the way from the ocean, like the truly anadromous species, but from the brackish downstream portions of tidal rivers (Lippson and Lippson 1997). Spawning occurs in the open freshwater areas of tidal rivers. In spring, after spawning, adults migrate back downstream. Concurrently, in the upstream spawning areas the eggs hatch and juveniles use tidal marshes as nursery grounds, where they seek shelter and feed (Mitsch and Gosselink 1993). As they begin to mature, the young migrate downstream to brackish waters (Lippson and Lippson 1997).

Spot and Weakfish

The spot (*Leiostomus xanthurus*) and the weakfish (*Cynoscion regalis*) are ocean species that enter estuaries in the spring and summer to feed (Lippson and Lippson 1997). While both are ocean spawners, the hatched larvae and juveniles enter estuaries and tidal rivers at an early age (Lippson and Lippson 1997) and use tidal marsh habitats as nursery grounds (Daiber 1982). There, they grow rapidly on the dense populations of invertebrates and small forage fish (e.g., killifish, silversides, shad) that inhabit tidal marshes as described above (Lippson and Lippson 1997). Spot and weakfish generally return to the ocean in autumn (Lippson and Lippson 1997).

Freshwater Fishes

Five of the 14 species of fish collected adjacent to the Empire Tract are considered freshwater fishes (Lippson and Lippson 1997):

- Black crappie (*Pomoxis nigromaculatus*);
- Brown bullhead (*Ameirus nebulosus*);
- Carp (*Cyprinus carpio*);
- Golden shiner (*Notemigonus crysoleucas*); and
- Pumpkinseed (*Lepomis gibbosus*).

Although they are considered freshwater species, these species also are able to tolerate portions of the estuary with slight to moderately brackish conditions. They may sometimes migrate downstream from freshwater areas. When they do, they tend to congregate in shallow streams and protected coves of the river (Lippson and Lippson 1997). Some move into the deeper channel waters as well. In spring, these fish move back upstream to a freshwater environment.

6.4.1.3 Essential Fish Habitat

Essential fish habitat (EFH) is defined in Section 3 of the Magnuson-Stevens Fishery Conservation and Management Act, (PL 94-265 as amended through October 11, 1996) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Regulations further clarify EFH by defining "waters" to include aquatic areas that are used by fish and may include aquatic areas that were historically used by fish where appropriate. A purpose of the act is to "promote the protection of essential fish habitat in the review of projects conducted under federal permits, licenses, or other authorities that affect, or have the potential to affect such habitat". An EFH assessment is required for a federal action (such as granting Department of the Army permits) that could potentially adversely impact essential fish habitat. Accordingly, an essential fish habitat assessment report (PS&S 1999) was prepared by the applicant for the Empire Tract and its vicinity for review by NMFS.

Managed fish species are those species that are managed under a federal fishery management plan. Managed fish species for New Jersey are listed in the *Guide to Essential Fish Habitat Designations in the Northeastern United States Volume IV* prepared by the National Oceanographic and Atmospheric Administration (NOAA 1999). This guide was used to evaluate what fish species might potentially be adversely affected by any proposed developments within the area. The mixing zone of the Hackensack River within the HMD has been designated as habitat for a number of managed species and their specific life history stages of concern (Table 6.4-2).

Table 6.4-2
Summary Table of Federally Managed Fish Species in HMD

Managed Fish Species (1)	Collected in the Lower Hackensack River	Collected on or Adjacent to Empire Tract
Atlantic Mackerel	Yes	No
Long-finned Squid	No	No
Short-finned Squid	No	No
Atlantic Butterfish	Yes	No
Bluefish	Yes	No
Spiny Dogfish	No	No
Summer Flounder	Yes	No
Scup	Yes	No
Black Sea Bass	Yes	No
Surf Clam	No	No
Ocean Quahog	No	No
Red Hake	No	No
Winter Flounder	No	No
American Plaice	No	No
Atlantic Sea Herring	No	No
King Mackerel	No	No
Spanish Mackerel	No	No
Cobia	No	No
Windowpane Flounder	No	No
Sand Tiger Shark	No	No
Sandshark	No	No

(1) Source: NOAA *Guide to Essential Fish Habitat Designations in the Northeastern United States*. 1999.

None of the managed fish species listed for the lower Hackensack River were found near or on the Empire Tract during the studies summarized above. The Hackensack River adjacent to the Empire Tract provides suitable environmental conditions for black sea bass and winter flounder. However, no individuals of these species were recorded in the prior studies reviewed of the Hackensack River near the Empire Tract. Tidal habitat for estuarine fish species on the Empire Tract is presently limited to 22 acres of tidal marsh located along the Hackensack River. The remainder of the Empire Tract does not receive daily tidal flow from the Hackensack River due to the existing dike and tide gate system present.

The EFH assessment also examined the potential effects on prey species for the managed fish species potentially occurring within the area. Prey species are defined as being a forage source for one or more designated fish species. They are normally found at the bottom of the food web in a healthy environment. Prey species found in the Hackensack River estuary include killifish, such as the mummichog, as well as silversides and herrings (HMDC 1989).

6.4.1.4 Shellfish

Shellfish, as defined by the NJDEP (NJAC 7:7E-8.3), include hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), American oysters (*Crassostrea virginica*), bay scallops (*Argopecten irradians*), and blue mussels (*Mytilus edulis*). More generally, the term shellfish also can apply to other invertebrate species that are harvested for human consumption, including shrimp and crabs. The blue crab (*Callinectes sapidus*), not listed by NJDEP as a shellfish, is known to occur throughout the tidal portions of the Hackensack River (NJTA 1986). No shellfish have been reported as occurring within the Hackensack River in the vicinity of the Empire Tract. A two-year study conducted by HMDC (HMDC 1992) did not identify any shellfish species in the portion of the Hackensack River north of Route 3. This is attributable to low salinity in this portion of the river relative to Newark Bay. Salinity levels in the Hackensack River adjacent to the Empire Tract are generally less than 10 ppt, and as a result it is very unlikely that the area would support commercially harvestable populations of shellfish (J. Kraeuter, personal communication). Thus, no shellfish were identified in the project area or on the Empire Tract.

6.4.1.5 Fishing Industry

New Jersey Administrative Order EO-40-19 (6 August 1984) prohibits the sale or consumption of fish and shellfish taken from the tidal Hackensack River due to the potential presence of contaminants. Despite this ban, some people do catch blue crabs from the river for consumption (NJTA 1986). Additionally, people have been observed fishing in the river's tributaries (TAMS 1997).

While there is no commercial fishing permitted in the Hackensack River, there is a bait fish industry. Mummichogs and grass shrimp (*Palaemonetes pugio*) are harvested in the HMD and sold as bait outside of the HMD (Smith 1998). The Hackensack River estuary also plays an indirect role in the bait fish industry, as there are migratory fish species (e.g., alewife, blueback herring, and gizzard shad) within the river that are known to migrate into commercial fishing grounds outside of the HMD. These migratory species serve as the food base for commercially harvested marine fish, such as bluefish, weakfish, and others.

6.4.2 Empire Tract

6.4.2.1 Fish Communities

A fish survey was conducted within the Empire Tract to update previous fish surveys of the creeks on the Empire Tract and obtain additional site-specific data on fish populations. It was also used to update the data previously collected on fish populations within the general vicinity (Empire, Ltd. 1992, TAMS 1997). Limited sampling was conducted over a three-day period in April 1997. Fish were sampled at a total of five locations within Bashes Creek, Muddabach Creek, and Moonachie Creek (Figure 6.4-2). At each of five collection stations, a gill net was deployed and left overnight for a period of 15 to 17 hours. The net featured five panels of varying mesh sizes ranging from 0.5 to 2 inches. All fish collected were counted, identified, and measured. While this survey cannot be considered the most thorough inventory of potential fish species utilizing the Empire Tract possible, USACE feels it is sufficient to characterize the site for the purposes of making a permit decision on the basis of the following:

Table 6.4-3 presents results of the fish sampling conducted within the Empire Tract via gill net during the April 1997 sampling effort. Since the survey was of a short-term nature and was limited to one sampling method (gill net), it is possible that species in addition to those sampled occur on the Empire Tract. Four fish species were collected during the 3-day period:

- Common carp (*Cyprinus carpio*);
- Brown bullhead (*Ameiurus nebulosus*);
- Pumpkinseed (*Lepomis gibbosus*); and
- Mummichog (*Fundulus heteroclitus*).

With the exception of the mummichog, these species are primarily freshwater species, although all four can tolerate some degree of salinity. All of these species were previously collected within the Hackensack River during the HMDC survey.

Table 6.4-3 describes the number of individuals of each species collected, and provides the mean length and minimum and maximum lengths of sampled fish. To document field conditions during fish sampling, concurrent in-situ water quality measurements (temperature and dissolved oxygen) were collected at each station during the fish sampling. These measurements are presented in Table 6.4-4. Dissolved oxygen concentrations recorded were greater than 4 mg/L at most locations during spring months, indicating that the locations sampled in these creeks should support fish at least during colder months (USEPA 1986).

Fish habitat on the Empire Tract also is provided by a 22-acre portion of the site, located east of the existing berms and adjacent to the Hackensack River, that is tidally inundated on a daily basis (Figure 6.4-2). The remaining wetlands on the Empire Tract are not inundated daily by the tides. Habitat for species such as killifish may be provided in the tidally influenced portion of the site adjacent to the Hackensack River. Additional habitat may be provided elsewhere on site when the wetlands are occasionally flooded from rain events, presenting foraging opportunities in shallow water areas. However, hydrological data collected at the Empire Tract from May 1998 to present, coupled with historical observations made by investigators, indicate that the creeks on site seldom flood over their banks. In addition, tide gates at the base of the creeks on the Empire Tract near the Hackensack River inhibit the movement of larger fish from the Hackensack River onto the site. The tide gate at Losen Slote has a grate that allows water movement, but prohibits larger fish from moving upstream.

The following points can be made regarding existing fish habitat on the Empire Tract:

- The Empire Tract is not inundated under normal circumstances; in fact, hydrological studies indicate the site seldom floods; the property was not inundated during Hurricane Floyd, and overbank flooding appears to be a rare event (see Section 6.13);
- Tidal gates along Moonachie Creek, Bashes Creek, Muddabach Creek and Losen Slote have been inspected by biologists contracted by USACE and deemed to be a reasonably effective barrier to fish movement under normal circumstances, with the exception of killifish and smaller fish capable of moving through small openings;
- The Empire Tract does not offer habitat for any of the managed fish species listed by NMFS in the mixing zone of the Hackensack River; if additional species are present, they do not carry any special regulatory status; and
- Fish habitat on the Empire Tract is limited to creeks that receive the majority of theirflow from storm water runoff from upgradient-developed areas. The wetlands lack surface water that might provide fish habitat. The streams are turbid throughout most of the year, and exhibit seasonally low DO levels (see Section 6.3)

Table 6.4-3
Fish Collected on the Empire Tract - April 1997

Station	Species	No. Collected	Mean Length (cm)	Minimum Length (cm)	Maximum Length (cm)
BC 1	Common carp	5	33.0	14.3	61.5
	Brown bullhead	2	20.5	20.0	21.0
	Pumpkinseed	1	9.5	9.5	9.5
	Mummichog	6	9.0	8.7	9.5
BC 3	Common carp	12	26.7	8.3	52.0
	Brown bullhead	1	28.5	28.5	28.5
	Mummichog	29	9.1	8.5	10.0
MUDD 2	Common carp	6	46.6	26.5	80.0
	Brown bullhead	4	28.0	27.0	29.0
	Mummichog	2	9.0	9.0	9.0
MC 1	Common carp	1	66.5	66.5	66.5
	Brown bullhead	2	27.3	27.0	27.5
	Mummichog	6	9.0	8.8	9.0
MUDD 3**	Mummichog	10	9.0	9.0	9.0

Notes:
1. Collected via gill net.
2. ** Water less than 3 inches (7.6 cm) deep at this stretch of Muddabach Creek.
3. BC = Bashes Creek; MUDD = Muddabach Creek; MC = Moonachie Creek.
4. Sampling conducted by TAMS during the week of April 7, 1997.

Table 6.4-4
Water Quality Measurements at Empire Tract
Fish Sampling Stations - April 1997

Fish Station	Date	Temperature (°C)	Dissolved Oxygen (mg/L)
BC 1	4/8/97	10	6.0
BC 3	4/8/97	12	7.2
MUDD 2	4/7/97	15	2.7
MC 1	4/8/97	10	4.7
MUDD 3	4/9/97	10.5	9.8

Notes: BC = Bashes Creek; MUDD = Muddabach Creek; MC = Moonachie Creek.

Source: In-situ water quality measurements using YSI meters, TAMS 1998.

6.4.2.2 Shellfish

No shellfish species were observed on the Empire Tract during fish collection and benthic macroinvertebrate studies. Salt marshes characteristically act as nursery grounds for shellfish larvae. However, those such as the tidal marsh found within the 22-acre portion of the Empire Tract along the Hackensack River would not be expected to fulfill this function due to their lower salinity.

Section 6.4 References

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6.5 WILDLIFE

6.5.1 Overview

This section provides a summary of the wildlife species and habitats found on the Empire Tract and in the HMD. First, the method by which the species and habitats within the HMD and on the Empire Tract were identified is discussed. Subsequently, a summary of the available data on habitats and species present in the HMD and on the Empire Tract is presented. Potential project impacts are discussed in Section 7.5.

6.5.1.1 Wildlife Habitat Evaluation Methods

Two general approaches can be taken to evaluate the potential of a site to support various types of wildlife. One approach is to census the number of animals observed at the site to obtain an indication of what species might be supported. A second approach is to analyze components of the habitat in order to predict what species might use it.

Under the first approach, censusing methods are used to obtain an estimate of the relative abundance of different species present in an area. If the census period is of an adequate duration, and an appropriate censusing method is chosen, a reasonable assessment may be obtained of the types and numbers of animals utilizing a given area. A limitation of this approach is that censusing methods are often biased (Ralph and Scott 1981). For example, if censusing is based upon sighting birds or animals alone, more secretive species that hide in dense vegetation may be missed or their relative abundance may be underestimated. Conversely, counting birds that are singing as "breeding males" may actually overestimate the number of actual breeding birds, since the birds singing might not all breed.

In addition, collecting census data is time consuming and requires a significant effort, and as a result, the censusing period is usually limited. Unless a site is censused for several years, year-to-year population fluctuations would be missed. It would not be known, for example, if the census results are representative of all years, since some species may not occur in a given area every year. As a result, possible extrapolation of results beyond the census period could result in inaccurate conclusions regarding habitat quality.

A second approach relies upon modeling to evaluate the wildlife habitat in an area. A model can be described as an equation or series of equations used to describe hypothetical relationships between different variables, or parameters, measured in the environment. In this case, the model is used to describe the suitability or quality of habitat for a given species (e.g., Short 1985) or group of species occupying a similar niche in the community based on previous research. Such groups of species are typically referred to as guilds (Root 1967).

The modeling approach relies on studied relationships between structural characteristics of the environment (e.g., vegetation type and height, presence of water) and a measure of the relative abundance of individuals (such as density) of a given species or group of species. Many studies describe the relationship between habitat characteristics such as vegetation type or complexity and the use of an area by different species. Using the modeling approach, field observations and/or measurements are taken of these characteristics, and inferences are drawn through modeling regarding whether or not the habitat present is suitable for a given species or guild.

The Habitat Evaluation Procedures (HEP) developed by the USFWS are examples of models designed to predict the suitability of wildlife habitat for different species. The parameters measured in the field under this method are based upon prior studies in the literature deemed useful in defining habitat for a given species. The Indicator Value Assessment (IVA), an expanded version of the WET methodology described in Section 6.2, also incorporates models that predict the value of a wetland habitat for wildlife habitat. The IVA/WET methodologies provide a more general/sense of wildlife habitat value for regional planning purposes as opposed to the HEP approach. These models are developed based on documented relationships on studied sites. As these models are developed, they are often checked against data on the density or abundance of individuals of a species in a given location, to verify their accuracy at predicting habitat value.

Limitations of the modeling approach are that models have not been developed for every species, they usually rely upon a series of assumptions, they are usually semi-quantitative and thus the inputs and results may be subjective, and they are best applied as a means of ranking the relative value of different areas, rather than assessing the absolute habitat value of a given site. Models generally have less resolution than a direct censusing approach (Van Horne 1983). Finally, both the modeling and censusing approaches may assume that the density of a species is indicative of habitat quality, but this is not always the case (Van Horne 1983).

For this analysis of the Empire Tract, both of the above approaches were integrated to characterize the wildlife habitat of the Empire Tract and the HMD. A 1-year-long census study (TAMS 1998) was made of the Empire Tract to obtain an indication of what bird species are present. This study (hereafter referred to as the "avian study") was included as Appendix F to the DEIS. In addition, incidental observations of reptiles, amphibians, mammals, and other wildlife made during the avian study were recorded (TAMS 1998). While these analyses cannot record every species utilizing the Empire Tract, when considered in conjunction with regional information on species recorded in the HMD by others, they provide a list of birds using the Empire Tract adequate for this analysis.

Regional wildlife data previously summarized in the DEIS for the SAMP (USEPA and USACE 1995) was used to describe regional habitat quality. Other regional studies were incorporated as well. For the regional analysis, the IVA method described in Section 6.2 was used to rank the value of wetland habitats on the Empire Tract relative to other wetlands in the HMD. Data have been collected throughout the HMD using a variety of different methods, and therefore the data may not be directly comparable to that collected on the Empire Tract. The IVA method gives an overall score or ranking of the habitat value of site wetlands relative to other sites based on structural indicators, such as the size of the wetland area and frequency of inundation. While this method is of limited use in determining actual or "absolute" habitat value for different species guilds, it does provide some comparison at a regional scale of the predicted habitat value of the site relative to that of other wetland habitats in the HMD. It also allows some limited comparisons to be made between present and future conditions.

6.5.1.2 Habitat Quality and Landscape Context

The value of habitats for wildlife generally varies relative to their size and position within the larger landscape. For example, a large contiguous area of habitat is considered to be more valuable than a small, isolated parcel of similar habitat, especially if the smaller parcel is surrounded by development (Harris 1984; Terborgh 1990). Moreover, should an area of habitat be located adjacent to other areas of suitable habitat (as opposed, for example, to a developed area) its value as habitat may be enhanced. Habitat connectivity and the proximity of habitat "islands" to one another are believed to reduce the probability of extinction of local populations of wildlife species (Harris 1984; Atmar and Patterson 1993, 1994; Lindenmayer and Nix 1993; and others). These relationships are difficult to quantify and are species-specific.

It should be noted that the "value" ascribed to a given wildlife habitat also is a function of management objectives. For example, if the objective is to maximize local diversity of bird species, a smaller area with more high quality habitat types may have value equal to or greater than a large homogenous parcel. If the management objective is to maintain large homogenous habitats for species that prefer them, then the habitat value of a larger parcel would be considered higher than that of a small parcel. Management objectives for the HMD are outlined in the *Wildlife Management Plan for the Hackensack Meadowlands* prepared by the U.S. Fish and Wildlife Service (USFWS 2000) and are described in Section 7.5 and Chapter 8 of this EIS.

6.5.2 Regional Setting

As discussed in Section 6.2, the approximately 8,500 acres of remaining wetlands and aquatic habitats (including open water) within the HMD comprise one of the largest remaining wetland aquatic habitat complexes in the New York-New Jersey Harbor estuary (USFWS 1998). According to the USFWS (1998), these tidal wetlands and open water habitats are important for concentrations of waterfowl, wading birds, shorebirds, raptors, anadromous fish, estuarine fish, and terrapin turtles. They also are considered an important part of the New York-New Jersey Harbor estuary system (USFWS 1998). In recognition of its regional significance, the Hackensack Meadowlands has been designated as a "Regionally Significant Habitat Complex" under the USEPA-sponsored New York-New Jersey Harbor Estuary Program, (USEPA and USACE 1995) (see Section 6.9). This designation is not a regulatory status and the area was not designated as a "Focus Area" (USEPA and USACE 1995). However, this designation is intended to provide local, state and federal resources, planning agencies, conservation organizations, and the public with information essential to making informed land use decisions (USFWS 1998). Figure 6.9-1 shows the location of the Hackensack Meadowlands in relation to other significant habitat complexes in the New York-New Jersey Harbor area. Wetland resources in these complexes are recommended by USFWS for preservation and maintenance because of their environmental value on a regional scale (USFWS 1999).

6.5.2.1 Habitat Types of the Hackensack Meadowlands

A variety of wildlife habitat types are present in the HMD. Although some wildlife species may use several different habitats, others may be specialized and use only one or two different types. The habitat types that are found throughout the HMD include the following (USEPA and USACE 1995):

- bay and mudflats;
- low salt marsh;
- high salt marsh;
- common reed (tidal);
- freshwater marsh;
- brackish impoundment; and
- open water.

The above habitat types are all considered wetlands or special aquatic sites, and were described in more detail in Section 6.2; their distribution in the HMD is shown in Figure 6.2-2. In addition to these habitats, "upland" habitat exists in remaining undeveloped areas of the HMD. Much of the existing upland habitat within the HMD is found throughout former wetland areas that were historically filled (Section 6.2). The following summary adapted from the SAMP DEIS (USEPA and USACE 1995) describes each habitat in more detail from the perspective of wildlife use.

Bay and mudflat habitats support an ecological community adapted to daily tidal fluctuations. At the base of this food chain is detritus and biota washed in from the adjacent tidal marsh and open bay areas, as well as benthic invertebrates (Section 6.6) that live on microscopic algae, plants and animals within the mud. Shorebirds (e.g., sandpipers) and waterfowl feed on these invertebrates, which include minute crustaceans and molluscs, as do juvenile fish that enter the shallows with the tide. Fish communities within the shallow water and bay areas of the HMD are discussed in Section 6.4. In some areas of the HMD where tidal flow has been restricted due to dikes and tidal gates, these mudflat habitats exist along creeks and ditches but they are not tidally inundated.

Low salt marsh habitats are dominated by saltmarsh cordgrass (*Spartina alterniflora*), the dominant salt marsh plant species in the northeastern United States (Mitsch and Gosselink 1993). This species grows in the intertidal zone between mean water and mean high tide levels, so it is subject to daily tidal inundation. Salinity within this habitat generally ranges between 10 and 15 ppt (Mitsch and Gosselink 1993). Wildlife species utilizing the low salt marsh habitats include birds such as clapper rails *(Rallus longirostris)*, common moorhen *(Gallinula chloropus)*, waterfowl, and other species that feed on insects, crabs and other invertebrates that this community supports. Muskrats *(Ondatra zibethica)* occasionally feed on *Spartina* roots, but generally prefer freshwater marshes upgradient.

High salt marsh habitats are generally found near the mean high tide level, and are dominated by salt marsh hay (*Spartina patens*) and seashore saltgrass (*Distichlis spicata*). High salt marsh provides habitat for many of the same species found in the low tidal marsh areas. However, since high salt marsh is inundated far less regularly than the low salt marsh, waterfowl such as black ducks *(Anas rubripes)* and mallards *(Anas platyrhynchos)* may breed within this habitat. White-footed mice *(Peromyscus leucopus)* and meadow voles *(Microtus pennsylvanicus)* may use this habitat, as well as raptors (hawks and owls) that feed on the rodents throughout the year.

Common reed (*Phragmites australis*) habitats cover about 62% of the HMD (USEPA and USACE 1995), and comprise much of the remaining tidal marsh areas within the New York - New Jersey Harbor area. The wildlife habitat value of common reed is a somewhat controversial subject among biologists. Many reports in the literature (reviewed in Lapin and Randall 1993) appear to focus on control of this species, which is considered a weedy invader that aggressively competes against native species of marsh vegetation. Since this species may invade areas and exclude other species, it can reduce the diversity of habitats and species within an area (Roman et al. 1984). This has happened historically in the New York - New Jersey Harbor area, especially in areas that have been subject to diking and ditching for mosquito control purposes (USEPA and USACE 1995). Because of this, tidal wetland restoration projects, including several in the New York-New Jersey Harbor estuary, often focus on control of common reed (Lapin and Randall 1993). Due to the tenacious nature of this species, these control efforts are not always successful without repeated herbicide application (Lapin and Randall 1993). It is important to note that while common reed is usually associated with wetlands (Reed 1988), common reed also can invade upland areas and marsh areas that have tidal flow restricted by tide gates and similar structures.

Nevertheless, common reed habitats do provide habitat for wildlife. In Europe, common reed is regarded as an ecologically and economically beneficial plant that offers habitat for a variety of wildlife species (Nevell et al. 1997). When interspersed with other habitats, such as open water and mudflat areas, the value of common reed habitat may be greater, since this interspersion provides breeding, foraging, and resting habitat for several species.

Large undisturbed tracts of wetland dominated by common reed may be considered to be of lesser habitat value than an equivalent area of low or high tidal marsh dominated by saltmarsh cordgrass or other species. However, large areas of undisturbed common reed marsh can be expected to support greater numbers of individuals of species present, relative to smaller areas of similar habitat. This is because of the well-known "species–area" relationship, showing that species diversity generally increases with the area censused (MacArthur and Wilson 1967; Connor and McCoy 1979). The species–area relationship is due to "sampling effect," which results from sampling a larger area (Connor and McCoy 1979), but also appears due to area-dependent requirements of some species (Ambuel and Temple 1983).

For example, certain species that utilize common reed habitat, such as the northern harrier (*Circus cyaneus*), require larger areas for foraging. If sufficient undisturbed area were not available on a site, they might not breed or even forage there. Other species that inhabit these common reed marshes (e.g., clapper or Virginia rails *[Rallus limicola]*) are secretive in nature (Bull and Farrand 1979) and may avoid the edge of the marsh. Since marshes covering a smaller area have a higher proportion of edge habitat, these species may benefit from large contiguous areas.

In addition, large areas of common reed habitat would be expected to provide greater habitat value than developed areas of equivalent or even larger size. This is because the number of species that have adapted to distinctive /developed environments is a subset of the overall species pool in this area.

Common reed vegetation provides habitat for muskrats that are fed upon by birds of prey. It also provides breeding and resting habitat for water birds such as rails, bitterns and moorhens, and passerine birds and raptors (USEPA and USACE 1995). Stands of common reed support insect populations that are fed upon by migrating birds (USEPA and USACE 1995). The dense cover of common reed provides protection from wind for occasional migrating and wintering waterfowl, especially along the edges of tidal creeks and open water areas.

Freshwater marsh areas are present within the HMD in Kearney Marsh, the Penhorn Creek Basin, areas of North Bergen and near Teterboro Airport, Losen Slote Creek, and within the lower Hackensack River floodplain. Most of this habitat was formerly dominated by grasses present in freshwater meadows, but now much of this habitat is dominated by common reed. Nevertheless, this is considered a distinct habitat type because it is not influenced by the tide, and the lower salinity allows species such as leopard frogs *(Rana sphenocephala)*, snapping turtles *(Chelydra serpentina)*, painted turtles *(Chrysemys picta)* and spotted turtles *(Clemmys guttata)* and other freshwater species to survive.

Brackish impoundments in the HMD have largely been created by historical diking and ditching. These impoundments are highly productive, providing habitat for large numbers of wading birds and shorebirds during migration, as well as the largest known breeding population of pied-billed grebes *(Podilymbus podiceps)* in New Jersey. They also provide breeding habitat for red-winged blackbirds *(Agelaius phoeniceus)*, marsh wrens *(Cistothorus palustris)*, and other birds. These impoundments generally do not support amphibians, or other animals primarily associated with freshwater (e.g., Virginia rail, pumpkinseed sunfish *[Lepomis gibbosus]*).

Open waters are found within the Hackensack River itself, as well as within its tributaries. These areas provide habitat for fish and, macroinvertebrates, (Section 6.4) and the birds, which feed on them.

Upland areas, although not a wetland or a special aquatic site, are described below because they are present within the HMD and exist within the vicinity of the Empire Tract. Apart from the above habitats, little undeveloped open space remains in the Meadowlands District that is not a filled upland. Most remaining upland habitat within the HMD is on the inactive parts of solid waste disposal areas that have revegetated (USEPA and USACE 1995). These areas are concentrated in 22 inactive landfill areas (approximately 850 acres) and are dispersed in fragmented upland areas throughout the District (approximately 900 acres) (USEPA and USACE 1995).

Most upland areas in the vicinity of the Empire Tract have been developed. A 14-acre wooded area exists in the vicinity of Losen Slote, immediately north of the Empire Tract. This woodland area consists of pin oak *(Quercus palustris)*, red oak *(Quercus rubra)*, white oak *(Quercus alba)*, black gum *(Nyssa sylvatica)*, sweetgum *(Liquidambar styraciflua)* and red maple (*Acer rubrum)*, and is considered a stopover site for neotropical migrant passerine birds including species that have declined in the eastern United States in recent decades (Kane and Githens 1997).

6.5.2.2 Wildlife of the Hackensack Meadowlands

Extensive studies of wildlife have been conducted within the Hackensack Meadowlands (Bosakowski 1983; HMDC 1989; HMDC 1992; USEPA and USACE 1995; Kane and Githens 1997; TAMS 1998). A list of the species found in the HMD has been compiled by the HMDC from a review of 33 references and from their own surveys. These studies have shown that a wide variety of amphibians, reptiles, fish, birds, and mammals are found in the HMD. While the HMD has political boundaries and is not a biological entity or zone, the species list compiled for the SAMP DEIS (USEPA and USACE 1995) can be considered indicative of regional wildlife diversity. This list was presented as Appendix G in the DEIS.

According to the SAMP DEIS (USEPA and USACE 1995), the HMD provides habitat for the following:

- 31 species of fish
- 10 species of amphibians
- 15 species of reptiles
- 24 species of mammals
- over 250 species of birds, including over 60 known to have bred in the HMD

The following sections describe in more detail the various wildlife species that have been documented as occurring within the HMD.

Birds of the Hackensack Meadowlands District

Over 250 species of birds have been recorded within, and 66 species are known to have bred within, the HMD (HMDC 1987). USFWS (1998) summarized the results of regional information on different species groups.

Waterfowl

Waterfowl includes ducks, geese and swans. The marshes in the HMD are used extensively by waterfowl, including over 20 species of ducks (USEPA and USACE 1995). According to USFWS, waterfowl primarily use the region during the fall migration and during winter months. The USFWS has conducted midwinter aerial survey counts of waterfowl in the New York-New Jersey Harbor. The primary species observed in aerial surveys were Canada geese *(Branta canadensis)*, American black duck *(Anas rubripes)*, and mallards. Canvasback *(Aythya valisineria)*, greater scaup *(Aythya marila)*, gadwall *(Anas strepera)*, and American coot *(Fulica americana)* also were present in lesser numbers (USFWS 1998). Boat surveys made during fall and winter months along tidal waterways within the HMD also noted "abundant" numbers of green-winged teal *(Anas crecca)* in Mill Creek and Cromakill Creek and other small creeks (USFWS 1998).

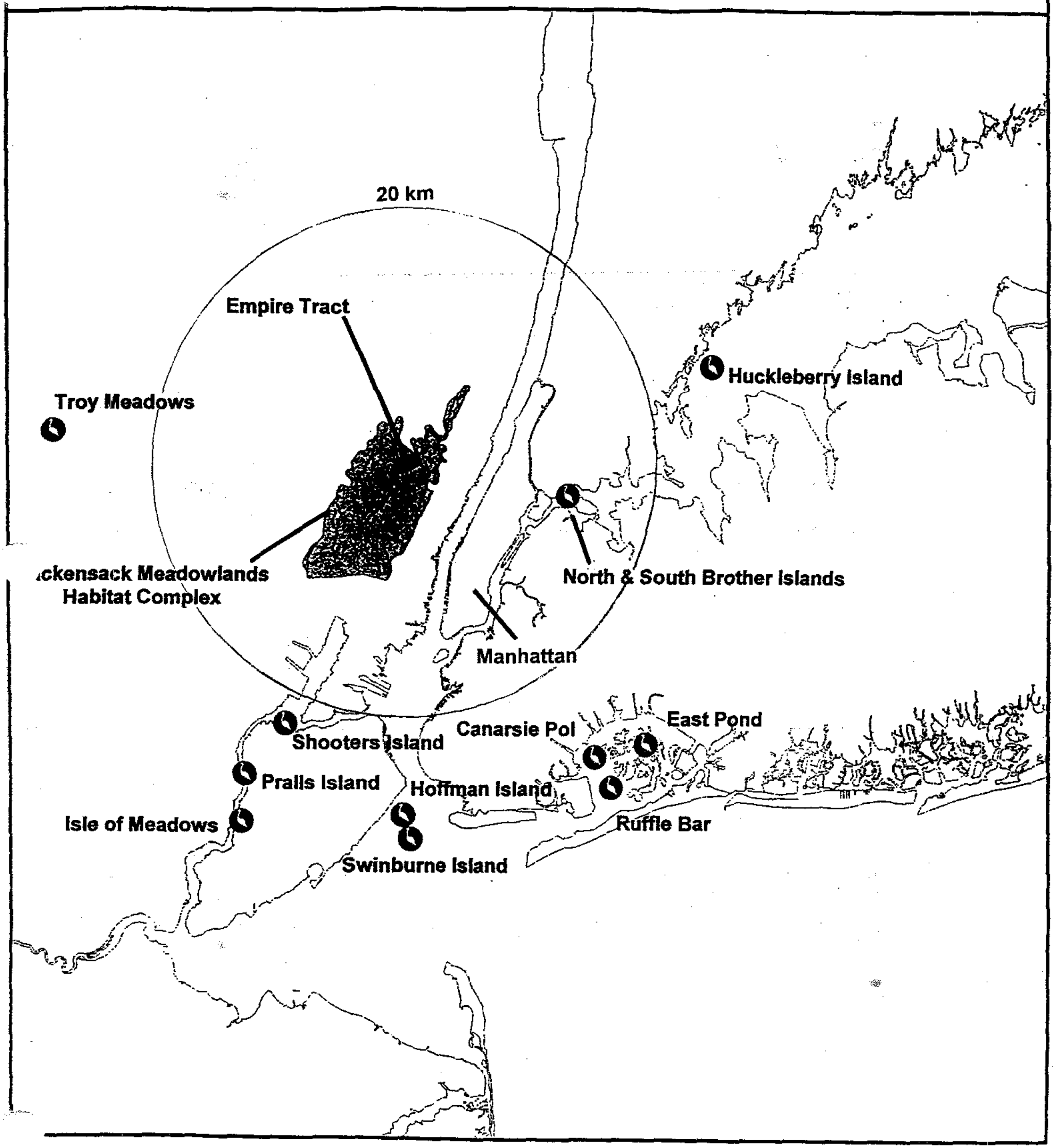
Waterfowl species noted as breeding in the Hackensack Meadowlands by USFWS (1998) included Canada goose, mallard, American black duck, gadwall, green-winged teal, blue-winged teal *(Anas discors)*, ruddy duck *(Oxyura jamaicensis)*, pied-billed grebe, and American coot. Examples of important waterfowl breeding areas in the HMD include the Kingsland freshwater and brackish impoundments managed by the NJMC, and Kearny Marsh.

Important migration and wintering areas include the Sawmill Creek Wildlife Management Area, located approximately 3.5 miles southwest of the Empire Tract. This 900-acre wetland, mudflat and open water area is in the process of converting from a common reed marsh to a low salt marsh dominated by *Spartina*, as dikes are breached and sea levels slowly rise (Kane and Githens 1997). The area is considered to be a prime stopover point for the waterfowl migration in spring and fall due to extensive open water and mudflat areas.

Colonial Waterbirds

The Hackensack Meadowlands are used by long-legged wading birds such as herons, egrets and ibises that forage on fish and crustaceans in shallow water areas. According to the USFWS (1998), the most abundant wading birds in the New York-New Jersey Harbor estuary are the black-crowned night heron *(Nycticorax nycticorax)*, snowy egret *(Egretta thula)*, glossy ibis *(Plegadis falcinellus)*, cattle egret *(Bubulcus ibis)*, and great egret *(Casmerodius albus)*. These birds nest in colonies located in the Arthur Kill and other locations in the harbor area (Figure 6.5-1). No colonies have been reported in the HMD. Birds in some of the colonies shown in Figure 6.5-1 may be within foraging distance of the Empire Tract (see Section 6.5.3.2), given that herons may travel up to 20 km (12.4 miles) per day to forage (Custer and Osborne 1978). Regionally important areas for waterbirds within the HMD include Kearney Marsh, which is heavily used by herons, common moorhen, gulls, and other birds, and Sawmill Creek Wildlife Management Area.

Regional Heronries within 20 km (12.4 mi) of the Empire Tract[A]



Source: U.S. Fish and Wildlife Service 1998
Notes: [A]See text Section 6.5.2.2.1 for explanation.

Figure 6.5-1

Raptors

Raptors are birds such as hawks and owls that feed on live prey such as rodents and birds. Raptors noted by USFWS (1998a) as using the Hackensack Meadowlands during migration and winter include the northern harrier, northern goshawk *(Accipiter gentilis)*, rough-legged hawk *(Buteo lagopus)*, red-tailed hawk *(Buteo jamaicensis)*, Cooper's hawk *(Accipiter cooperii)*, American kestrel *(Falco sparverius)*, short-eared owl *(Asio flammeus)*, and long-eared owl *(Asio otus)*. Northern harrier, red-tailed hawk, and American kestrel also have been known to breed in the HMD (Table 6.5-1). Of these species, the northern harrier, northern goshawk, Cooper's hawk and short-eared owl are state-listed endangered species (see Section 6.8).

Shorebirds

Shorebirds are birds such as sandpipers that forage along shoreline areas in habitats such as marshes, mudflats and shallow water areas. According to USFWS (1998), these habitats in the HMD are important for thousands of migrating shorebirds during spring, late summer, and fall months. The most abundant species noted in surveys at the Kingsland impoundment tidal flat, near the NJMC Environmental Education Center at DeKorte Park, were the semi-palmated sandpiper *(Calidris pusilla)*, lesser yellowlegs *(Tringa flavipes)*, short-billed dowitcher *(Limnodromus griseus)*, and dunlin *(Calidris alpina)*, although 31 species were noted. Daily counts exceeded 5,000 birds at that location during peak migratory periods (USFWS 1998). The intertidal mudflats near Sawmill Creek are another important feeding ground for shorebirds, with over 40 species noted (USEPA and USACE 1995).

Migratory Passerines and Land Birds

The HMD also provides habitat for migratory land birds, both during breeding and migration periods. The HMD is located at the convergence of the Hudson River and Atlantic flyways, which are traveled by a variety of bird species during their spring and fall migrations. Several species, referred to as neotropical migrants as they winter in the tropics of Central and South America, have suffered from regional population declines attributed to habitat loss both in the United States and on their wintering grounds (Terborgh 1990; Finch 1991). Many of these birds are forest species that may utilize a variety of wooded habitats during migration.

Other Recent Regional Studies

New Jersey Breeding Bird Atlas

The *New Jersey Breeding Bird Atlas*, a joint effort of the New Jersey Audubon Society (NJAS) and Cape May Bay Observatory, has summarized results of annual breeding bird surveys. While censusing methods differ from the methods used to census the Empire Tract, the atlas provides a useful indication of the diversity of breeding birds present within the HMD. A database search was conducted of species recorded as breeding within the area encompassed by the Weehawken topographic quadrangle, which covers the northern portion of the HMD and includes the area of the Empire Tract. A total of 34 bird species were recorded within the Weehawken quadrangle as confirmed breeding, probably breeding or possibly breeding (Table 6.5-1).

Table 6.5-1
Status of Breeding Birds in the New Jersey Breeding Bird Atlas Report[A]
Located in the Weehawken USGS Quadrangle[B]

Species	Latin	Years Recorded	Status
American bittern	*Botaurus lentiginosus*	1995	PR
Green heron	*Butorides striatus*	1993, 1994	C
Yellow-crowned night heron	*Nycticorax violacea*	1994	PR
Canada goose	*Branta canadensis*	1993, 1994	C
Wood duck	*Aix sponsa*	1994	C
American black duck	*Anas rubripes*	1994	PR
Mallard	*Anas platyrhynchos*	1994	C
Blue-winged teal	*Anas discors*	1994	PO
Northern shoveler	*Anas clypeata*	1994	C
Gadwall	*Anas strepera*	1994	C
Northern harrier	*Circus cyaneus*	1995	C
American kestrel	*Falco sparverius*	1994	PR
Red-tailed hawk	*Buteo jamaicensis*	1994	PO
Ring-necked pheasant	*Phasianus colchicus*	1993, 1994	PR
Clapper rail	*Rallus longirostris*	1994	PO
Virginia rail	*Rallus limicola*	1995	PR
Common moorhen	*Gallinula chloropus*	1994, 1995	C
Killdeer	*Charadrius vociferus*	1993, 1994	C
Spotted sandpiper	*Actitis macularia*	1993, 1994, 1995	C
Least tern	*Sterna albifrons*	1994	C
American woodcock	*Scolopax minor*	1995	PR
Rock dove	*Columba livia*	1993, 1994	C
Mourning dove	*Zenaida macroura*	1994	PR
Eastern screech-owl	*Otus asio*	1997	PR
Common barn owl	*Tyto alba*	1995	C
Chimney swift	*Chaetura pelagica*	1993, 1994	PR
Belted kingfisher	*Megaceryle alcyon*	1994	PR
Downy woodpecker	*Picoides pubescens*	1993, 1994	C
Hairy woodpecker	*Picoides villosus*	1994	PR
Northern flicker	*Colaptes auratus*	1993, 1994	C
Eastern kingbird	*Tyrannus tyrannus*	1993, 1994	C
Willow flycatcher	*Empidonax traillii*	1994, 1995	C
Great-crested flycatcher	*Myiarchus crinitus*	1994	PO
Northern rough-winged swallow	*Stelgidopteryx serripennis*	1994	C

Notes:
A. NJAS, 1999.
B. This quadrangle map includes the Empire Tract
Status: PO = Possible, PR = Probable, C = Confirmed
Source: Walsh et al, 1999. New Jersey Breeding Bird Atlas

New Jersey Audubon Hackensack River Studies

An inventory of Hackensack River bird communities, including those in the HMD, was conducted by the NJAS from 1994 to 1996. This study was designed to inventory wildlife use across a broad region, spanning the entire 50-mile length of the Hackensack River (Kane and Githens 1996). NJAS gathered information from 32 sites along the Hackensack River, ranging from Lake Tappan in Rockland County, New York to Kearney Marsh in the southern portion of the HMD. Each site was visited approximately once a month and censused during a time period between 20 minutes and 2 hours, by a team of two biologists. Observations were recorded from a single location (often from a boat).

Locations sampled within the HMD in the NJAS study included areas adjacent to the Empire Tract such as the forested area of Losen Slote and portions of Moonachie Creek. The Moonachie Creek observation site included Bashes Creek, Moonachie Creek and Doctor's Creek south of the Empire Tract. All observations were made from points adjacent to the site, such as the Barge Club, Veterans Boulevard, Empire Boulevard, and the Hackensack River.

According to the NJAS report, breeding birds at Losen Slote included mallard and gadwall, spotted sandpiper *(Actitis macularia)*, American crow *(Corvus brachyrhynchos)*, barn swallow *(Hirundo rustica)*, blue jay *(Cyanocitta cristata)*, downy woodpecker *(Picoides pubescens)*, tufted titmouse *(Parus bicolor)*, marsh wren, yellow warbler *(Dendroica petechia)*, common yellowthroat *(Geothlypis trichas)*, song sparrow *(Melospiza melodia)*, and red-winged blackbird.

Resident species recorded in the vicinity of Moonachie Creek included yellow-crowned night heron *(Nycticorax violacea)*, green heron *(Butorides striatus)*, mallard, gadwall, northern harrier, Virginia rail, common moorhen, spotted sandpiper, killdeer *(Charadrius vociferus)*, willow flycatcher *(Empidonax traillii)*, marsh wren, yellow warbler, common yellowthroat, swamp sparrow, and red-winged blackbird. No criteria were provided in the NJAS report as to how "resident species" were determined. "Non-breeding residents" included great-blue heron *(Ardea herodias)*, great egret, snowy egret, least tern *(Sterna albifrons)*, and double-crested cormorant *(Phalacrocorax auritus)*.

In addition, observations were made during spring and fall months at nine locations within the Hackensack Meadowlands (Kane and Githens 1997). Weekly counts were conducted from April to May 1995, and from September to October 1995 at the Moonachie Creek site, and from April to May 1995 at the Losen Slote site. The objective of these counts was to identify critical migratory bird habitats in the area. Forest migrants recorded at Losen Slote during this censusing included flycatchers (5 species), warblers (18 species), ruby-crowned kinglet *(Regulus calendula)*, blue-gray gnatcatcher *(Polioptila caerulea)*, vireos (3 species), thrushes (5 species), cedar waxwing *(Bombycilla cedrorum)*, red-winged blackbird (*Agelaius phoeniceus)*,rose-breasted grosbeak *(Pheucticus ludovicianus)*, bobolink *(Dolichonyx oryzivorus)*, orchard oriole *(Icterus spurius)*, Baltimore oriole *(Icterus galbula)*, American goldfinch *(Carduelis tristis)*, and sparrows (4 species). Migrant waterfowl using the pond at BCUA included American black duck, green-winged teal, northern shoveler *(Anas clypeata)*, hooded *(Lophodytes cucullatus)* and common mergansers *(Mergus merganser)*, and ruddy duck.

Migrant species recorded at the Moonachie Creek site by NJAS observers included herons, egrets, Virginia and sora rails *(Porzana carolina)*, common moorhen, American black duck, yellowlegs, snipe *(Gallinago gallinago)*, least *(Calidris minutilla)* and semi-palmated sandpipers, short-billed dowitcher, Forster's *(Sterna forsteri)* and least terns, northern flicker *(Colaptes auratus)*, eastern kingbird *(Tyrannus tyrannus)*, purple martin *(Progne subis)*, swallows, yellow-rumped warbler *(Dendroica coronata)*, bobolink (*Dolichonyx oryzivous)* and three species of sparrows. Notable sightings included 95 semi-palmated sandpipers on July 25, 1995; 40 green-winged teal on October 19, 1995; and 29 ruddy ducks on October 31, 1995. These observations indicate that regional habitats within 1 mile of the Empire Tract provide migratory bird habitat.

Mill Creek Mitigation Site Baseline Survey (August 1997- February 1998)

Avian census data were recorded between August 1997 and February 1998 at the Mill Creek Mitigation Site located northeast of the Empire Tract, across the Hackensack River. The data are representative of "baseline" conditions before the area was disturbed and converted into a wetland mitigation site. Table 6.5-2 provides a list of species that were recorded from towers located at the site.

Field Reconnaissance of Hartz Mountain Mitigation Site

A field reconnaissance of the adjacent Hartz Mountain wetland mitigation site located across the Hackensack River from the Empire Tract was made on September 25, 1997 by USACE and HMD representatives, and their contractors. While censusing data were not recorded, observations made during the field reconnaissance indicated that hundreds of green-winged teal and other migratory waterfowl were using the mitigated wetland, as well as shorebirds, herons, and egrets (Paul Bovitz, WESTON, personal observation 1998). Field observations on that day indicated that larger numbers of migratory waterfowl, shorebirds, and other water birds were using the mitigated wetland area than the surrounding common reed areas.

Table 6.5-2

Avian Species Occurring at NJMC's Mill Creek Mitigation Site During Baseline Survey (August 1997 to February 1998) and Some Statistical and Distributional Data

Species	Sightings	Mean Ind/Sighting (SD)	Relative Abundance (N=977)	Temporal Distribution for Study Period
red-winged blackbird	149	2.77(2.75)	0.42	8/5-2/10
green-winged teal	17	8.41(7.0)	0.144	8/20-2/10
swamp sparrow	68	1.32(0.53)	0.09	8/5-2/10
mallard	32 2	16(1.42)	0.072	8/5-2/10
barn swallow	7 4	14(4.58)	0.03	8/5-9/6
American black duck	15	1.87(1.02)	0.029	8/5-2/10
common yellowthroat	18	1(0)	0.018	8/20-10/1
Canada goose	3 5	33(2.05)	0.016	9/6-11/25
marsh wren	15	1.07(0.25)	0.016	8/5-2/10
snowy egret	16	1(0)	0.016	8/20-10/1
yellow-rumped warbler	12	1.33(0.62)	0.016	9/16-2/10
least sandpiper	7	2(1.69)	0.014	8/20-8/25
Corvus spp.	3 4	.33(4.71)	0.013	8/5-11/25
gadwall	5 2	6(1.85)	0.013	8/20-10/1
black-capped chickadee	7 1	71(1.03)	0.012	10/21-2/10
northern harrier	10	1.2(0.4)	0.012	8/30-2/10
northern waterthrush	6	1.33(0.47)	0.008	9/16-9/19
song sparrow	6	1.17(0.37)	0.007	8/5-10/21
herring gull	3	1.67(0.94)	0.005	8/22-9/19
greater yellowlegs	3	1(0)	0.003	8/5
ring-billed gull	3	1(0)	0.003	8/22-9/19
spotted sandpiper	3	1(0)	0.003	8/5
American bittern	1	1(0)	*	9/19
American goldfinch	2	1(0)	*	8/30-10/1
American robin	1	1(0)	*	8/20
American tree sparrow	3	1(0)	*	11/25-12/19
bank swallow	1	1(0)	*	9/6
belted kingfisher	1	1(0)	*	8/5
common snipe	1	1(0)	*	9/16
Cooper's hawk	1	1(0)	*	11/21
double-crested cormorant	1	1(0)	*	8/20
downy woodpecker	1	1(0)	*	12/19
European starling	2	3(1)	*	8/20-8/22
great black-backed gull	2	1(0)	*	8/5-8/25
great blue heron	1	1(0)	*	9/6
green-backed heron	1	1(0)	*	9/19

Species are listed in order of relative abundance.

Relative abundance was not calculated for species with a "*". These were species sighted less than three times during the course of the study.

Table 6.5-2 (Continued)

Avian Species Occurring at NJMC's Mill Creek Mitigation Site During Baseline Survey (August 1997 to February 1998) and Some Statistical and Distributional Data

Species	Sightings	Mean Ind/Sighting (SD)	Relative Abundance (N=977)	Temporal Distribution for Study Period
lesser yellowlegs	2	1(0)	*	8/20-8/25
mourning dove	1	1(0)	*	9/10
northern goshawk	1	1(0)	*	11/25
northern rough-winged swallow	1	1(0)	*	9/6
palm warbler	2 1	5(0.5)	*	8/22-9/19
rock dove	1	1(0)	*	12/19
semipalmated plover	1	1(0)	*	8/5
semipalmated sandpiper	1	2(0)	*	8/30
short-billed dowitcher	1	2(0)	*	9/16
tricolored heron	1	1(0)	*	8/25

Species are listed in order of relative abundance.

Relative abundance was not calculated for species with a "*". These were species sighted less than three times during the course of the study.

Mammals of the Hackensack Meadowlands District

A list of mammal species commonly observed in the Hackensack Meadowlands (including scientific names) is provided in Table 6.5-3. With the exception of the white-tailed deer (*Odocoileus virginianus*), the larger mammals present in the metropolitan New York area present during colonial times have been extirpated. Remaining mammals in the HMD include muskrat, opossum, mice and voles, shrews, moles, raccoons, weasels, chipmunks, squirrels, bats, Norway rat, cottontail rabbit, and feral dogs and cats. Relative to birds, or to larger mammals, these species tend to be less wide ranging.

Reptiles and Amphibians of the Hackensack Meadowlands District

The Hackensack Meadowlands area supports a variety of reptiles and amphibians. Reptiles include turtles and snakes, while amphibians include frogs and salamanders. Since most amphibian species are intolerant of salinity, few species are present in the brackish marsh habitats of the Hackensack Meadowlands. A list of reptiles and amphibians present in the HMD is provided in Table 6.5-4. Amphibians and terrestrial reptiles often have small home ranges; the home ranges of some amphibians are less than 1 acre in extent (DeGraaf and Rudis 1983). Therefore, emphasis is placed on species present on the Empire Tract itself (Section 6.5.3.2).

Table 6.5-3
Mammals Observed in the
Hackensack Meadowlands District

Common Name	Scientific Name
Opossum	*Didelphis marsupialis*
Masked shrew	*Sorex cinereus*
Short-tailed shrew	*Blarina brevicauda*
Eastern mole	*Scalopus aquaticus*
Little brown bat	*Myotis lucifugus*
Keen's myotis	*Myotis keenii*
Small-footed myotis	*Myotis subulatus*
Big brown bat	*Eptesicus fuscus*
Raccoon	*Procyon lotor*
Long-tailed weasel	*Mustela frenata*
Striped skunk	*Mephitis mephitis*
Red fox	*Vulpes fulva*
Grey fox	*Urocyon cinereoargenteus*
Domestic dog	*Canis familiaris*
Domestic cat	*Felis domestica*
Eastern chipmunk	*Tamias striatus*
Eastern gray squirrel	*Sciurus carolinensis*
Source: HMDC, 1987	

Table 6.5-4
Amphibians and Reptiles Observed on the Hackensack Meadowlands District

Common Name	Scientific Name
Amphibians	
Eastern American toad	*Bufo americanus*
Fowler's toad	*Bufo woodhousei fowleri*
Northern cricket frog	*Acris crepitans*
Northern spring peeper	*Hyla crucifer*
Gray treefrog	*Hyla chrysoscelis/versicolor*
New Jersey chorus frog	*Pseudacris triseriata kalmi*
Bull frog	*Rana catesbeiana*
Green frog	*Rana clamitans melanota*
Southern leopard frog	*Rana sphenocephala*
Pickerel frog	*Rana palustris*
Reptiles	
Snapping turtle	*Chelydra serpentina*
Stinkpot	*Sternothaerus odoratus*
Eastern mud turtle	*Kinosternon subrubrum*
Spotted turtle	*Clemmys guttata*
Northern diamondback terrapin	*Malaclemys terrapin*
Eastern painted turtle	*Chrysemys picta*
Five-lined skink	*Eumeces fasciatus*
Northern water snake	*Nerodia sipedon*
Northern brown snake	*Storeria dekayi*
Eastern garter snake	*Thamnophis sirtalis*
Eastern ribbon snake	*Thamnophis sauritus*
Eastern hognose snake	*Heterodon platyrhinos*
Northern black racer	*Coluber constrictor*
Smooth green snake	*Opheodrys vernalis*
Eastern milk snake	*Lampropeltis triangulum*

Source: HMDC, 1987

6.5.3 Empire Tract

The wildlife habitat value of the 587-acre Empire Tract is influenced by several environmental factors. These include its location within a larger, approximately 1,070-acre undeveloped wetland and open water area (USFWS 1998) within the HMD that is segmented by the New Jersey Turnpike Eastern and Western Spurs and a natural gas line right-of way (Figure 6.2-2). Dikes at the site also interrupt direct hydrological connections to the river, and habitat on the Empire Tract. Thus, the overall habitat value of the site should be considered on both a site-specific scale and in a regional landscape context.

6.5.3.1 Habitat Types on the Empire Tract

Habitat types identified on the Empire Tract are based upon a vegetation survey conducted in April, June, and July 1997 (TAMS 1998) that supplemented field investigations conducted in 1984 and 1991 (HMDC 1992). The 1997 survey was conducted in two stages. Stage one involved review of 1995 aerial photography. Stage two was a field survey conducted from roadways, avian transects lines, and other accessible areas to verify plant species composition (TAMS 1998).

The following habitat types have been identified on the Empire Tract:

- common reed (freshwater marsh)
- common reed (brackish marsh)
- low salt marsh
- bay and mudflats
- open water

In addition, about 18 acres of the site consisted of small scattered upland areas, many of which consist of fill material.

Figure 6.2-3 illustrates the approximate boundaries of these habitats on the Empire Tract. Table 6.5-5 presents the approximate acreage of each cover type and the approximate percentage of the site occupied by each cover type.

Common Reed – Freshwater Marsh

The vegetation survey (TAMS 1998) indicated that approximately 90% of the site is dominated by common reed (*Phragmites australis*). Most of the area dominated by common reed consists of freshwater "palustrine emergent" wetlands, where salinity is less than 0.5 ppt (Cowardin et al. 1979). These wetlands are present throughout the western portion of the site (Figure 6.2-3).

Included within the area, identified as common reed freshwater marsh, are small areas in which other species of plants are found with common reed. These areas may be considered "remnant habitats" of former freshwater marsh vegetation found in the Hackensack Meadowlands. They consist of an 8-acre inclusion dominated by panic grass (*Panicum virgatum*), a 3-acre inclusion dominated by broom sedge (*Andropogon virginicus)*, and a 3-acre inclusion dominated by marsh fern (*Thelypteris palustris*), all growing in association with common reed. Roughly half the plant species identified on the Empire Tract are present within these areas.

Table 6.5-5
Acreage of Vegetative Cover Types on the Empire Tract

Vegetative Cover Types	Acres	Percent of Site
Vegetated Wetlands		
Common Reed (*Phragmites australis)*	527	90
Mixed-species Inclusions	14	2.4
Spikerush	2	<0.5
Cordgrass	<1	<0.5
Subtotal	**544**	**93**
Shallow Water		
Mudflats - Hackensack River	5	<1
Mudflats - On-site creeks	6	1
Permanently Inundated Hackensack River	7	1
Permanently Inundated On-site creeks	7	1
Subtotal	**25**	**4**
Upland		
Successional	18	3
Subtotal	**18**	**3**
TOTALS	**587**	**100**

Notes: Acreage and percentages are approximate.
Project also includes 2 acres of common reed wetland within the NJDOT right-of-way adjacent to the NJ Turnpike.

Source: Based upon TAMS field survey conducted in 1997.

The freshwater marsh areas on the Empire Tract support populations of breeding passerine birds, most notably the red-winged blackbird, swamp sparrow, American goldfinch, common yellowthroat, and others described in Section 6.5.3.2. Other species documented as using, or expected to use this habitat during at least part of their life based upon habitat requirements (Bull and Farrand 1977) include Virginia rail *(Rallus limicola)*, American bittern, least bittern, marsh wren, and other marsh birds. Waterfowl may occasionally use this habitat, particularly near the edge of open water areas during winter months, since the dense common reed stands may provide cover (USFWS 1998). These marshes also provide habitat for raptors, such as northern harrier, red-tailed hawk, sharp-shinned hawk *(Accipiter striatus)*, rough-legged hawk and others, particularly during migratory and wintering months (USFWS 1998).

Common Reed - Brackish Marsh

About one quarter of the area dominated by common reed consists of brackish marsh, as defined by salinity levels greater than 0.5 ppt. According to the USFWS classification system (Cowardin et al. 1979) "estuarine" wetland systems have a salinity greater than 0.5 ppt, and are tidally inundated. However, on the Empire Tract the presence of the tidal gates and berms near the mouth of the creeks crossing the site prevents regular inundation of these habitats; regular inundation which is a requirement for classification of a wetland as an "estuarine system" under the USFWS classification system (Cowardin et al. 1979). According to the USFWS (Tiner, personal communication 1998), the wetland and open water areas of the Empire Tract exhibiting salinity greater than 0.5 ppt would still be classified as estuarine emergent wetlands, even if tidal flows were restricted by tide gates and berms. Tidal inundation may occur during severe storm events, but the extent of true tidal influence in this area is unknown. The brackish wetlands on the Empire Tract are associated with the brackish portions adjacent to and along the Hackensack River, as shown in Figure 6.2-2.

Since the brackish wetlands also are dominated by common reed, they are visually indistinguishable from the freshwater wetlands dominated by common reed, and offer similar habitat for the species described above. As described in Section 6.2, since the salinity of the marsh may vary with storm events, drought events, and leaking tide gates, the area of marsh dominated by brackish conditions may vary temporally. There is no discrete "line" between fresh water and brackish areas, due to the dry conditions on site with respect to leaking tide gates and, rarely, overbank flow. However, common reed marsh characterized by brackish conditions would not be expected to have an identical species composition to a strictly freshwater environment. Species normally associated with freshwater, such as amphibians, snapping turtles, and garter snakes would not be expected to survive in the brackish conditions of these wetlands. Muskrats also use brackish marshes to a lesser extent than freshwater marshes.

Low Salt Marsh, Mudflats and Open Water

The remaining portions of the site consist of shallow water habitat composed of small creeks and drainage ditches, and segments of the Hackensack River within the property boundary lines (approximately 15 acres). Included within these areas are three habitat types: low salt marsh, bay and mudflats, and open water. Low salt marsh is limited to an approximately 1-acre area of smooth cordgrass (*Spartina alterniflora)* located on the eastern side of the New Jersey Turnpike; this area is tidally inundated from the Hackensack River. While limited in extent on the Empire Tract, low salt marsh habitat is considered to be highly productive and ecologically important in that it supports populations of species tolerant of higher salinity levels than are present in the brackish marsh (Mitsch and Gosselink 1993). Low tidal marsh provides habitat for migratory waterfowl, wading birds and shorebirds, as well as important habitat for juvenile fish (Mitsch and Gosselink 1993).

Mudflats and open water areas also are present in this portion of the site. These habitats are associated with the Hackensack River, and also with Moonachie, Bashes, Muddabach and Losen Slote creeks. While limited in extent, these areas nevertheless provide an important mix of habitats that would otherwise not be provided by monotypic stands of common reed alone. Because mudflats and open water areas interrupt the dense, homogenous stands of common reed, they allow water birds such as mallards, Canada geese, and shorebirds the opportunity to forage in the creeks and seek resting cover in the adjacent common reed. While monocultures of species such as common reed are not preferred by waterfowl, waterfowl benefit from the interspersion of common reed with water and other vegetation types (Cross and Fleming 1989).

Open water habitats in freshwater portions of the site also are used by muskrats. Both brackish and open water habitats also provide fish habitat (see Section 6.4).

The mudflat habitats associated with the intertidal fringe of the Hackensack River support two distinct stands of vegetation: a 2-acre area of dwarf spikerush (*Eleocharis parvula*) located at the northeastern portion of the site, and a 1-acre area of smooth cordgrass located at the southeastern portion of the site. Although these vegetated areas are limited in extent, they do provide foraging resources for waterfowl, shorebirds and other water birds, particularly during migratory periods.

Upland Habitat

Approximately 4% of the site (18 acres) is comprised of small, scattered upland areas. Plant communities on the upland areas include small, highly fragmented wooded areas, successional fields, and edge habitats. Many of these areas are present on historical fill material and consist largely of plant species adapted to disturbed soil conditions. Approximately half the plant species identified on the Empire Tract are present in these upland areas.

Upland areas are composed of trees such as cottonwood (*Populus deltoides*), tree-of-heaven (*Ailanthus altissima*), and smaller trees and shrubs such as black cherry (*Prunus serotina*), birch (*Betula* spp.), elderberry (*Sambucus canadensis*), and smooth sumac (*Rhus glabra)*. Additionally, successional field species include herbaceous species such as goldenrod (*Solidago* spp.), pokeweed (*Phytolacca americana*), and various grasses. The edge communities are narrow strips of land on either side of the bermed Transco right-of-way located in the northeastern portion of the site. They are composed of early old field plants and invading species of plants, such as pokeweed.

These edge communities may provide limited breeding habitat for common species of passerine birds, and potentially other species such as the ring-necked pheasant. They provide habitat for reptiles such as the garter snake, and potentially support amphibians such as toads. They also provide some habitat for small mammals such as mice, voles and Norway rats. Passerine bird species may use these areas during migration. These birds may include such species as yellow-rumped warbler and other warbler species, flycatchers, vireos, and other neotropical migrants. Trees within these areas also may be used to provide vantage points for raptors during migration.

6.5.3.2 Wildlife of the Empire Tract

Birds

Two bird surveys specific to the Empire Tract have been conducted: an avian survey conducted by GES in 1984, and an avian survey conducted from February 1996 through February 1997 (TAMS 1998). The methodology used for the 1996-1997 bird survey is summarized below and was approved by reviewing agencies prior to implementation.

During the 1-year censusing period, a team of biologists returned to eight pre-established sampling locations on the Empire Tract at weekly or bi-weekly intervals (TAMS 1998). The sampling locations consisted of five 16-foot-high towers and three transects that traversed the site. Towers acted as fixed-point observation locations from which teams of observers noted birds seen or heard. To minimize redundant observations, observers recording data simultaneously from each tower were in radio contact with each other. Transects ranged in length from 2,000 to 3,600 ft. Observers walked these transects stopping at regular, predetermined intervals to record all birds seen or heard. Collectively, these stations allowed observers to document bird habitat utilization on the site.

The data collected provide an indication of the type and relative abundance of species utilizing the Empire Tract. Data recorded during the avian survey included multiple observations of the same individuals using the site each day. For example, red-winged blackbirds were sighted 8,054 times, but the total number of individuals of this species using the site was probably far less.

Results are presented in the *Avian Survey Report for the Empire Tract* prepared by the applicant's consultant (TAMS 1998) and are summarized below. Federal-and state-listed threatened and endangered birds are discussed in Section 6.8. Of the 250 species previously noted as having occurred within the HMD, a total of 114 species were noted on the Empire Tract during the year-long survey (TAMS 1998). These are listed in Table 6.5-5, and are described below by their status on the site (permanent resident, summer resident, winter resident, and migratory/transient).

Permanent Residents

There were 29 species observed on the Empire Tract, which are considered permanent residents. Leck (1975, 1984) defined permanent resident species as those that are present year round in New Jersey. The most commonly observed permanent resident species on the Empire Tract was the red-winged blackbird, representing 62% of permanent resident bird observations.

The eight most commonly observed permanent resident species accounted for a total of 93% (12,199 of the 13,070 total) of all the permanent resident bird observations recorded during the survey. These eight species were: red-winged blackbird, American crow, Canada goose, mallard, European starling *(Sturnus vulgaris)*, song sparrow, ring-necked pheasant *(Phasianus colchicus)*, and American goldfinch.

Summer Residents

There were 28 species observed on the Empire Tract that are considered summer residents, defined as those present during the summer months in New Jersey (Leck 1975, 1984). The most commonly observed summer resident species was the swamp sparrow (*Melospiza georgiana*). There were 1,787 observations of swamp sparrows, representing 38% of summer resident bird observations.

The eight most commonly observed summer resident species of birds accounted for a total of 91% of the summer resident bird observations (4,297 of the 4,718 total) recorded during the survey. These eight species were: swamp sparrow, common yellowthroat, barn swallow, marsh wren, American robin *(Turdus migratorius)*, tree swallow *(Tachycineta bicolor)*, gray catbird *(Dumetella carolinensis)*, and willow flycatcher (*Empidonax traillii*). As with the permanent resident species, this finding further indicates that the avian ecological community of the Empire Tract is dominated by a few commonly observed species, with many less commonly observed species making up the balance. This trend is consistently observed in avian communities and is not unique to the Empire Tract.

Winter Residents

There were 10 species observed on the Empire Tract that are considered winter residents as defined by Leck (1975, 1984). These 10 species accounted for 248 total observations. The 10 species were: red-throated loon *(Gavia stellata)*, double-crested cormorant, rough-legged hawk, common snipe, great black-backed gull *(Larus marinus)*, ring-billed gull *(Larus delawarensis)*, American tree sparrow *(Spizella arborea)*, white-crowned sparrow *(Zonotrichia leucophrys)*, dark-eyed junco *(Junco hyemalis)*, and purple finch *(Carpodacus purpureus)*.

Breeding Species

A total of 11 species were confirmed as breeding on the Empire Tract in 1997, (Table 6.5-6) (TAMS 1998). All of these birds have been recognized historically as breeding in the HMD (HMDC 1992). The below table is conservative in that it is limited to species for which some activity associated with breeding, such as courtship behavior, birds flying with nesting material in their beaks, or other similar indicators was noted in the field. It is possible, given the size of the tract, that other species that nest in dense vegetation and are more difficult to see, such as rails or bitterns, or savannah sparrow, may also breed on site. It also is possible that species that did not breed on the Empire Tract during the avian study from 1996 to 1997 might breed on site sporadically during other years. It also is possible that some species exhibiting courtship behavior on the Empire Tract actually bred off site.

The data show that the most abundant species on site during the spring/summer breeding season is the red-winged blackbird. This species has been described as the most abundant bird in North America. The other most common species observed during summer months on the Empire Tract were starlings, common yellowthroat, and American robin.

Migratory/Transient Species

The remaining species documented as occurring on the Empire Tract can be considered migratory or transient species present during a portion of the year.

Avian Habitat Utilization

Since the site is located within the Atlantic flyway, the 27 acres of shallow water and mudflat habitats can be expected to provide some habitat for migratory waterfowl, shorebirds, and other species. The Empire Tract is a 587-acre open area that provides habitat for certain species of raptors, such as the northern harrier. Some of these species were noted during the yearlong survey. In addition, an existing undeveloped area immediately to the east of the site may provide additional raptor habitat (see Figure 7.2-2). The scattered trees present in the upland areas of the Empire Tract also may provide resting habitat for migratory passerines.

The 1996-1997 avian study of the Empire Tract recorded the number of observations made of each bird within each habitat over a 1-year period so as to assess habitat utilization of bird species seen on the Empire Tract (TAMS 1998). Bird utilization was quantified for three general habitats: wetlands (including low salt marsh, freshwater and tidal marsh), shallow water areas (including mudflats and open water areas), and uplands.

Table 6.5-6
Birds Observed on the Empire Tract

Common Name	Scientific Name
Red-throated loon	*Gavia stellata*
Pied-billed grebe	*Podilymbus podiceps*
Double-crested cormorant	*Phalacrocorax auritus*
American bittern	*Botaurus lentiginosus*
Least bittern	*Ixobrychus exilis*
Black-crowned night-heron	*Nycticorax nycticorax*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Green heron	*Butorides striatus*
Snowy egret	*Egretta thula*
American black duck	*Anas rubripes*
Canada goose	***Branta canadensis***
Gadwall	*Anas strepera*
Mallard	*Anas platyrhynchos*
Blue-winged teal	*Anas discors*
American kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine falcon	*Falco peregrinus*
Northern harrier	*Circus cyaneus*
Cooper's hawk	*Accipiter cooperii*
Sharp-shinned hawk	*Accipiter striatus*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Osprey	*Pandion haliaetus*
Ring-necked pheasant	***Phasianus colchicus***
King rail	*Rallus elegans*
Clapper rail	*Rallus longirostris*
Virginia rail	*Rallus limicola*
Sora	*Porzana carolina*
American coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Greater yellowlegs	*Tringa melanoleuca*
Lesser yellowlegs	*Tringa flavipes*
Semipalmated sandpiper	*Calidris pusilla*
Solitary sandpiper	*Tringa solitaria*
Spotted Sandpiper	*Actitis macularia*
Common snipe	*Gallinago gallinago*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Laughing gull	*Larus atricilla*
Ring-billed gull	*Larus delawarensis*
Mourning dove	*Zenaida macroura*
Rock dove	*Columba livia*
Chimney swift	*Chaetura pelagica*
Ruby-throated hummingbird	*Archilochus colubris*

Species shown in bold are confirmed as breeding on the Empire Tract

Table 6.5-6 (Continued)
Birds Observed on the Empire Tract

Common Name	Scientific Name
Belted kingfisher	*Megaceryle alcyon*
Northern flicker	*Colaptes auratus*
Downy woodpecker	*Picoides pubescens*
Eastern wood-pewee	*Contopus virens*
Willow flycatcher	*Empidonax traillii*
Alder flycatcher	*Empidonax alnorum*
Eastern kingbird	*Tyrannus tyrannus*
Tree swallow	*Tachycineta bicolor*
Bank swallow	*Riparia riparia*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Barn swallow	*Hirundo rustica*
American crow	*Corvus brachyrhynchos*
Blue jay	*Cyanocitta cristata*
Fish crow	*Corvus ossifragus*
Black-capped chickadee	*Parus atricapillus*
Tufted titmouse	*Parus bicolor*
House wren	*Troglodytes aedon*
Marsh wren	*Cistothorus palustris*
Sedge wren	*Cistothorus platensis*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
Hermit thrush	*Catharus guttatus*
Wood thrush	*Hylocichla mustelina*
American robin	***Turdus migratorius***
Gray catbird	***Dumetella carolinensis***
Northern mockingbird	*Mimus polyglottos*
Brown thrasher	*Toxostoma rufum*
American pipit	*Anthus rubescens*
Cedar waxwing	*Bombycilla cedrorum*
European starling	***Sturnus vulgaris***
Red-eyed vireo	*Vireo olivaceus*
Solitary vireo	*Vireo solitarius*
Warbling vireo	*Vireo gilvus*
Yellow-throated vireo	*Vireo flavifrons*
Yellow warbler	***Dendroica petechia***
Mourning warbler	*Oporornis philadelphia*
Northern waterthrush	*Seiurus noveboracensis*
Palm warbler	*Dendroica palmarum*
Prairie warbler	*Dendroica discolor*
Wilson's warbler	*Wilsonia pusilla*
Yellow-rumped warbler	*Dendroica coronata*
Common yellowthroat	***Geothlypis trichas***
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Northern cardinal	*Cardinalis cardinalis*
Indigo bunting	*Passerina cyanea*

Species shown in bold are confirmed as breeding on the Empire Tract

Table 6.5-6 (Continued)
Birds Observed on the Empire Tract

Common Name	Scientific Name
Rufous-sided towhee	*Pipilo erythrophthalmus*
Song sparrow	***Melospiza melodia***
American tree sparrow	*Spizella arborea*
Chipping sparrow	*Spizella passerina*
Field sparrow	*Spizella pusilla*
Savannah sparrow	*Passerculus sandwichensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-throated sparrow	*Zonotrichia albicollis*
Dark-eyed junco	*Junco hyemalis*
Fox sparrow	*Passerella iliaca*
Le Conte's sparrow	*Ammodramus leconteii*
Lincoln's sparrow	*Melospiza lincolnii*
Swamp sparrow	***Melospiza georgiana***
Bobolink	*Dolichonyx oryzivorus*
Red-winged blackbird	***Agelaius phoeniceus***
Eastern meadowlark	*Sturnella magna*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Northern oriole	*Icterus galbula*
Purple finch	*Carpodacus purpureus*
House finch	*Carpodacus mexicanus*
American goldfinch	***Carduelis tristis***
House sparrow	*Passer domesticus*
Source: Field observations conducted by TAMS from February 1996 through February 1997.	

Species shown in bold are confirmed as breeding on the Empire Tract

Over 93% of seasonal and resident species were observed in common reed wetland habitat at least once. These results were expected since this habitat covers 90% of the Empire Tract. Red-winged blackbirds, American crows, and European starlings were seen with greater frequency in this habitat than other species. Other species also demonstrated a preference for the wetlands habitat: 99% of swamp sparrow observations, 95% of common yellowthroat observations, 86% of the mallard observations, and 90% of Canada goose observations were in habitat considered by observers to be wetlands.

Fifteen species of waterbirds were observed utilizing shallow water habitat. Shallow water areas account for less than 5% of the site. These areas, which are not contiguous, consist largely of the three creeks described in Section 6.1, as well as a few drainage ditches with some common reed present. The most commonly observed species in shallow water was the mallard, followed by the Canada goose. These two species together accounted for about two-thirds of all bird observations in shallow water habitat. Three species were found exclusively in shallow water habitats: American coot, pied-billed grebe, and spotted sandpiper. These species were noted infrequently.

Upland habitat accounts for approximately 20 acres, scattered throughout the site. The upland habitat is primarily located along the Transco inspection road and near the edges of the property, and consists of fill material on which a variety of common upland plant species occur. On a per-acre basis, this habitat provided the greatest habitat diversity on the Empire Tract, based on observations collected during the 1996-1997 study period. In these upland areas, 64% of all seasonal and resident species of birds were observed. Over 30 of these species were woodland passerines, including wrens, warblers, sparrows, and flycatchers. American crow and red-winged blackbirds, both permanent residents, together accounted for 45% of the upland habitat observations.

Mammals of the Empire Tract

Table 6.5-3 lists mammals previously recorded in the Hackensack Meadowlands that could potentially utilize the Empire Tract. Site-specific data on mammals utilizing the Empire Tract were collected concurrently with avian survey of the Empire Tract. During that period, incidental observations of mammal species were recorded. This information was supplemented with site visits in April 1997. Biologists searched for mammals for a period of 5 days by walking roadways, the avian study transects, and other accessible areas (TAMS 1998). Observations of mammalian species included both direct sightings of animals and evidence of the presence of mammals, such as tracks and scat.

The mammal species observed on the site during the 1996-1997 and April 1997 surveys are listed in Table 6.5-7 in the order of frequency with which they were observed. All of the species observed have adapted fairly well to suburban habitats, or undeveloped habitats within urbanized areas. The most commonly observed mammals were the Norway rat (*Rattus norvegicus*), striped skunk (*Mephitis mephitis*), and the muskrat (*Ondatra zibethica*). These findings are similar to those of the GES (1984) survey reported in the EIAR (Empire, Ltd. 1992). Norway rats are a non-native species indigenous to Europe that arrived in this country during colonial times and rapidly colonized urban areas within the eastern United States. They are common in urban and industrialized environments, including landfills.

Muskrats are native species characteristic of freshwater and slightly brackish marshes. They are occasionally eaten by hawks (Willner et al. 1980). Since muskrats are often associated with common reed marsh habitat, a survey of muskrat burrows was conducted in April 1997 at stations along the banks of Moonachie Creek, Muddabach Creek, and Bashes Creek (TAMS 1998). The wildlife survey stations corresponded to the benthic sampling stations shown in Figure 6.4-2. Two 100-foot transects, one on each side of the creek, were established at each of the five stations. Creek banks adjacent to roadways (e.g., where Barrell Avenue meets Moonachie Creek, or where the Transco access road crosses Bashes and Moonachie creeks) were characterized by extremely steep-sided slopes dominated by a mixture of thorn/scrub species and common reed. Muskrat burrows were not observed in these areas. Away from roadways, an average of six burrows per 100 ft were counted along these creeks (typically three burrows on each side of a creek).

Table 6.5-7
Mammals Observed on the Empire Tract

Common Name [A]	Scientific Name
Norway rat	*Rattus norvegicus*
Striped skunk	*Mephitis mephitis*
Muskrat	*Ondatra zibethica*
Raccoon	*Procyon lotor*
Eastern cottontail	*Sylvilagus floridanus*
Eastern gray squirrel	*Sciurus caroliniensis*
Meadow vole	*Microtus pennsylvanicus*
Woodchuck	*Marmota monax*
Feral cat	*Felis domesticus*
Eastern chipmunk	*Tamias striatus*

Notes: [A] Order of species presented in table is from most commonly observed to least commonly observed.
Sources: Field observations conducted by TAMS from February 1996 to April 1997.

In addition to muskrat burrows, muskrat huts were counted. The occurrence of a fire on 7 April 1997 on the 545-acre parcel, in an area adjacent to the New Jersey Turnpike, facilitated an unobstructed view of an approximately 50-acre burned area. A total of 34 small-sized muskrat huts were counted within the formerly dense stand of common reed in the burned area. Permanent huts are typically constructed near water bodies, although muskrats will build temporary smaller huts, often used by juveniles, in dense vegetation (D. Smith May 6, 1997, personal communication to TAMS).

Reptiles and Amphibians of the Empire Tract

Biologists recorded incidental observations of reptiles and amphibians during the avian survey (February 1996 through February 1997) and in supplemental surveys conducted during a 5-day field investigation in April 1997 (TAMS 1998). During the field investigation, biologists searched for reptiles and amphibians by walking the transects developed for the avian survey, the on-site roadways such as the Transco inspection road, walking paths, and other accessible areas. Searches were conducted by examining suitable habitats, including banks, ponded areas, underneath debris, and sun-exposed surfaces. Searches were conducted on warm, sunny days when conditions were optimal for turtles and snakes to be sunning themselves.

The findings of these surveys were compared to the information presented in other studies (Empire, Ltd. 1992). Three species of reptiles were identified on site:

- snapping turtle;
- eastern painted turtle; and
- eastern garter snake.

The snapping turtle and eastern painted turtle were commonly observed sunning on exposed surfaces within the on-site creeks, such as floating logs or rocks. Remains of fish eaten by snapping turtles were found in gill nets at each station. Garter snakes were often observed in the vicinity of the Transco inspection road.

Those same three species were found during surveys conducted for other studies of the Empire Tract (Empire, Ltd. 1992). In addition, previous studies noted the occurrence of an amphibian species, the southern leopard frog, in the vicinity of the Empire tract. This species was not observed on site during the 1996-1997 survey studies (Empire, Ltd. 1992). No evidence of any species of frogs on site was found during the 1996-1997 surveys (TAMS 1998).

6.5.3.3 Habitat Value of the Empire Tract in Relation to Other Wetlands in the HMD

As discussed in Section 6.2, the IVA method was used as a regional planning tool to determine the relative value of different wetland areas within the HMD. The IVA analysis is discussed in Section 6.2, and Figure 6.2-6 shows the distribution of the IVA scores reflecting the predicted wildlife habitat value of different assessment areas in the HMD.

Review of Figure 6.2-6 indicates that the IVA scores for wildlife calculated for different wetland areas of the HMD ranged from 10 to 100, with most wetland areas in the HMD generally ranging from 50 to 80. Areas indicated as having high regional habitat value, such as Walden Swamp, Sawmill Creek and the marshes along Berry's Creek, were scored 89, 92 and 100, respectively. Area 2E, which covers most of the Empire Tract, scored a range of values for different wildlife species groups, which would fall in the 50 to 80 range observed over much of the HMD. IVA values for wildlife habitat of the Empire Tract were re-scored by an interagency team in April and May 2000 and are summarized in Table 6.2-4. The scoring was done on the basis of different species groups that may use the region. These scores provide the basis for comparison of predicted future conditions for different development alternatives on the Empire Tract.

Summary of Existing Wildlife Habitat Quality of the Empire Tract

- The wildlife habitat of the Empire tract is characterized nearly entirely by common reed marsh, which is not regularly inundated by the tides.

- The wildlife habitat evaluation of the Empire Tract is comparable to most of the other wetland sites in the HMD that were ranked using the IVA method as reported in the SAMP DEIS (USEPA and USACE 1995). However, in comparison with high quality habitat estuarine marsh where tidal inundation occurs daily, such as at the Sawmill Creek Wildlife Management Area, the wildlife habitat quality of the Empire Tract would be considered relatively low.

- From a landscape perspective, the wildlife habitat value of the Empire Tract is greatly influenced by its location within a relatively undeveloped tract of approximately 1,070 acres of marsh and open water area segmented by the New Jersey Turnpike and Transco Natural gas pipeline. It also is affected by its location adjacent to the New Jersey Turnpike, adjacent industrial/commercial development and other regional impacts.

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6.6 BENTHOS

While "benthos" refers to all organisms living in, on, or near the bottom substrate in aquatic habitats, the focus of this section is on benthic invertebrates, since other benthic organisms such as fish (Section 6.4) and aquatic plants (Section 6.2) are addressed elsewhere in the FEIS. Benthic invertebrates are those invertebrate species that spend at least a portion of their life cycle in water. Examples include snails, aquatic earthworms, insect larvae, amphipods, crabs and other crustaceans.

Due to their limited mobility, many species of benthic invertebrates are unable to move to cleaner waters when their environment becomes polluted. Because of this, and the fact that they have short life spans, they are often used as indicators of changing environmental conditions, such as in monitoring the effects of contaminated sediments on aquatic communities (Weber 1973). The abundance and diversity of benthic invertebrates can provide a measure of the quality of aquatic habitat. For example, aquatic habitats impacted by contamination or disturbance may have fewer species, and a lesser abundance of some species groups compared to undisturbed or uncontaminated communities. Benthic invertebrates also are important because they are at the base of the food chain and provide a food source for fish, waterfowl, shorebirds, and other animals.

6.6.1 Regional Setting

While the benthic fauna of the New York-New Jersey Harbor estuary may be slowly recovering as water quality gradually improves (Crawford et al. 1994), the benthic macroinvertebrate fauna of Newark Bay and the Hackensack River still reflect the historical impacts of water pollution and habitat degradation from a variety of sources. Newark Bay and Hackensack River sediments are contaminated with a variety of pollutants, including nitrates from wastewater, as well as metals, PCBs, dioxins and other compounds (Crawford et al. 1994). For example, the benthic macroinvertebrate community of Newark Bay appears to be dominated by polychaete worms, which are "habitat generalists" and have adapted to environmentally stressful conditions (USACE 1997). Additional indicators suggesting that Newark Bay is a stressed environment include the fact that the overall abundance of benthic macroinvertebrates was considered "moderate", and species diversity was found to be low in prior studies (USACE 1997).

The water quality in Newark Bay can be considered a primary determinant of water and sediment quality in the lower Hackensack River, since approximately 70% of the volume of water in the lower Hackensack River enters tidally from the bay (USEPA and USACE 1995). Moreover, the river receives other pollutant inputs from industrial, municipal and non-point sources. As a result, the benthic invertebrate community within the Hackensack River has been adversely affected.

Sediments within the lower Hackensack River contain heavy metals, PCBs, and other contaminants, and their toxicity was recently investigated by the National Oceanographic and Atmospheric Administration (NOAA) as part of their National Status and Trends Program (Long et al. 1995b). Sediment was sampled at three locations in the Hackensack River (NOAA Phase 2 locations 12, 13, and 14) approximately 2 miles south of the Empire Tract. Laboratory toxicity tests were conducted by exposing the amphipod *Ampelisca abdita* to the sediment collected from these locations. This species is a crustacean commonly used as a test organism to evaluate the toxicity of sediment. Sediment collected from two of the three locations sampled was found to be highly toxic to this species.

From 1987 through 1988, HMDC (presently NJMC) conducted an aquatic inventory of the Hackensack River that included two Hackensack River sampling stations adjacent to the Empire Tract, referred to as Trap Net 5 (TN 5) and Seine 4 (S4). These locations were the same as the fish sampling locations shown previously in Figure 6.4-1. Six benthic macroinvertebrate taxa were collected from the two Hackensack River stations (Table 6.6-1). The number of individuals within each of six species is expressed as number per square meter (sq. m). This number is considerably less than the number of taxa recorded in prior studies of Newark Bay (USACE 1997), which could be related to differences in sampling technique or intensity, as well as habitat differences or seasonal factors.

Table 6.6-1
Benthic Invertebrates Collected in the Hackensack River Adjacent to Empire Tract

Common Name	Scientific Name	TN 5 (average per sq. m)[A]	S4 (average per sq. m)[A]
Aquatic earthworm	Class *Oligochaeta*	262	196
Hydrobid snail	*Hydrobia totteni*	63	162
Midge larvae	Family *Chironomidae*	25	44
Phantom midge larvae	*Chaoborus*	2	2
Platform mussel	*Congeria leucophaeata*	0	7
Water mite	*Hydracarina*	0	2

Note: (A) Number of individuals per square meter.
Source: HMDC, 1989.

6.6.2 Empire Tract

Benthic invertebrate samples were collected in April 1997 to provide current data on the species composition and abundance of benthic invertebrate communities occurring on the Empire Tract (TAMS 1997). Benthic samples were collected at a total of 15 stations along Moonachie Creek (MC), Muddabach Creek (MUDD), and Bashes Creek (BC). The approximate sample locations are shown in Figure 6.4-1. Quantitative samples were collected using an Ekman grab sampler, which is a device used to collect sediment and its associated organisms. Three benthic samples were collected at each station, resulting in a total of 45 samples. The samples were washed and processed in the field and subsequently analyzed in the laboratory.

A total of six benthic taxa were collected from creeks at the Empire Tract:

- Aquatic earthworm (*Oligochaeta*);
- Midge larvae (*Chironomidae*);
- Biting midge larvae (*Ceratopogonidae*);
- Scud (*Amphipoda*);
- Pouch snail (*Physella* sp.); and
- Dragonfly larvae (*Libellulidae*).

Table 6.6-2 presents the number of individuals per square meter of each taxa collected at the 15 stations. Similar to the two Hackensack River locations, the dominant benthic organism collected at each station in the Empire Tract creeks was the oligochaete worm. Densities ranged from a low of 797 worms per sq. m at Moonachie Creek Stations 5 and 6 to a high of 6,131 worms per sq. m at Muddabach Creek Station 3. Midge larvae were encountered at all but two stations, but at a much lower density than the worms. The other four taxa were observed infrequently, as shown in Table 6.6-2.

Table 6.6-2
Benthic Invertebrates on the Empire Tract*
(expressed as number per square meter)

Sampling Station	Oligochaetewo rm	Midge larvae	Biting midge larvae	Amphipod	Pouch snail	Dragonfly larvae
BC 1	826	145	--	--	--	--
BC 2	2,739	14	--	--	--	--
BC 3	1,116	39	--	--	--	--
BC 4	3,362	29	--	58	--	--
MUDD 1	1,942	333	--	--	--	--
MUDD 2	1,754	449	--	--	--	--
MUDD 3	6,131	39	29	--	--	--
MUDD 4	1,812	14	--	--	--	--
MC 1	2,826	14	--	--	--	--
MC 4	1,812	--	--	--	--	--
MC 5	797	29	--	--	--	29
MC 6	797	39	29	--	--	--
MC 7	1,608	14	--	--	275	14
MC 8	2,072	--	--	--	126	--
MC 9	1,319	29	--	14	--	--

Notes:
(*) Data based on April 1997 collection by TAMS.
BC = Bashes Creek; MUDD = Muddabach Creek; MC = Moonachie Creek;
"--" indicates organism not collected at station in 1997.

The data collected during this 1997 survey were similar to the data reported by Greiner Engineering Sciences, Inc. (GES, Inc) (Empire, Ltd. 1992). In general, the structure of the benthic invertebrate communities of the Empire Tract and the Hackensack River were similar, although there was a greater abundance of oligochaetes in sediments within the Empire Tract creeks. GES, Inc. reported that all of its sampling stations on the Empire Tract were strongly dominated by oligochaetes and that there existed a lack of species diversity at each station. The dominance of oligochaetes and chironomids, which tend to be pollution tolerant, as well as the low number of other species observed, is indicative of low diversity and possibly impacted habitat.

6.6.2.1 Marsh Surface Invertebrates

Although species occurring on the marsh surface are not considered benthos, some species may be aquatic or semi-aquatic and are therefore discussed here. The following discussion summarizes studies conducted on the Empire Tract of invertebrates that utilize marsh habitat. Since the majority of the Empire Tract is not regularly inundated, the sampling was conducted by collecting invertebrates found within quadrats established on the marsh surface.

Marsh surface invertebrates were inventoried at 16 sampling locations by GES, Inc. and are reported in the EIAR (Empire, Ltd. 1992). Although the data are 10 years old, conditions on the site have not changed significantly since data were collected. Most of the sampling points used by GES, Inc. were located along the banks of the Hackensack River (3 stations) and the on-site creeks (12 stations). One station was located within a small (< 1 acre) stand of panic grass (*Panicum virgatum*). Three randomly located 0.1-sq m quadrats were inventoried at each location. Surface debris was moved during sampling, but no excavation was conducted.

Table 6.6-3 presents a listing of the invertebrates as reported in the EIAR (Empire, Ltd. 1992). The invertebrates found on the Empire Tract are associated with several types of habitats. In general, the hydrobid snail, springtail, amphipod, sowbug, and platform mussel are associated with open water marsh habitats. Aphids and ladybird beetles are generally associated with the seed heads of common reed. Slugs, crickets, grasshoppers, ants, beetles, spiders and centipedes are generally associated with an upland or transition area from high marsh to drier conditions, and are not typically found in an inundated marsh environment.

Overall, results of the marsh surface sampling effort indicated that the area of the Empire Tract that is adjacent to the Hackensack River provides suitable conditions to support invertebrates that are associated with open-water marsh habitat, while conditions at the remainder of the site benefit those taxa that tend to occur in upland or transitional habitats. For example, GES, Inc. found that the density of those invertebrates associated with open water marsh habitat displayed a decrease with increasing distance from the Hackensack River. As seen in Table 6.6-3, most of the springtails and almost 90% of the hydrobid snails were collected at the stations adjacent to the river. Similarly, 90% of amphipods were identified in the river vegetation sampled. Platform mussels were collected only at the Hackensack River stations.

The most abundant taxa observed along the banks of the on-site creeks were aphids and ants, while the panic grass area was observed to support aphids and centipedes. The creek stations featured other taxa that tend to occur in upland or transitional habitats (e.g., centipedes, slugs, grasshoppers, spiders, crickets). None of these taxa were observed at the Hackensack River stations.

Populations of mosquito larvae were not noted or estimated during these marsh surface surveys, since invertebrate sampling was performed on the sediment and marsh surface of the wetland. Mosquito larvae would be expected in the overlying water column, if present, and in floating vegetation or debris, but not in the sediment samples. The hydrology of the Empire Tract wetlands was modified by a tide gate and dike system, which is maintained by the Bergen County Mosquito Control Division. One reason the tide gate and dike system was created was to manage water levels in wetlands to control mosquito populations by removing surface waters and minimize flooding on wetlands. The low invert of the tide gates effectively drains the creeks and wetlands and restricts tidal flow from the river, thereby removing surface water from the wetlands to minimize mosquito larvae habitat. Mosquito larvae are expected to be present in site creeks; however, mosquito larvae provide a prey base for aquatic organisms including fish. Swallows and other birds, as well as bats may feed upon adult mosquitoes.

Table 6.6-3
Total Number of Marsh Surface Invertebrates on Empire Tract
(number per sq m(A))

Invertebrate	Scientific Name	Stations Adjacent to Hackensack River (n=3)	Stations Adjacent to On-Site Creeks (n=12)	Station Within Panic Grass Stand (n=1)
Springtail	*Anurida maritima*	TN(B)	TN(C)	0
Hydrobid snail	*Hydrobia minuta*	7569	1013	0
Aphid	Family Aphididae	3267	2548	163
Ladybird beetle	*Naemia seriata*	207	327	0
Amphipod	*Orchestria* sp.	294	33	0
Platform mussel	*Congeria leucophaeata*	163	0	0
Marsh sowbug	*Philoscia vittata*	0	65	0
Centipede	Class Chilopoda	0	240	65
Slugs	Order Stylommatophora	0	381	0
Ants	Family Formicidea	0	4803	0
Grasshopper	Family Acrididea	0	240	0
Spider	*Grammonota* sp.	0	65	0
Cricket	*Gryllus* sp.	0	610	0
Beetle	Order Coleoptera	0	33	0

Notes:
TN = Judged too numerous to count.
HR = Hackensack River station.
(A)Number converted from number/sq ft to be consistent with previous tables
(B)Springtails determined to be TN at one HR station (total of 650 at other two stations).
(C)Springtails determined to be TN at one creek station. (total of 51 at five other stations).
Source: Meadowlands Town Center, Hackensack Meadowlands Development Center General Plan Application, Volume II - *Environmental Impact Assessment Report* (Empire, Ltd., 1992).

Section 6.6. References

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6.7 RESOURCE CONTAMINATION/HAZARDOUS WASTE SITES

The purpose of this section is to describe potential regional and site-specific sources of hazardous contamination.

6.7.1 Regional Setting

The Hackensack Meadowlands is located within a highly industrialized, urbanized landscape (see Section 6.1), subject to air pollution (Section 6.16) and water pollution (Section 6.3) resulting from both present day and historical activities. The SAMP DEIS has documented 68 industrial discharges, 3 power generating plants, 7 sewage treatment plants, 32 combined sewer overflows, 12 emergency overflows and 16 landfills within the Hackensack Meadowlands District (USEPA and USACE 1995).

Historic activities also have resulted in groundwater pollution in some areas of the HMD, as well as soil and sediment contamination (USEPA and USACE 1995). Sources of this pollution include former landfills and hazardous waste sites, as well as industrial "background" contamination of soils, water, and sediment from a variety of sources in the region. Examples of these sources are: (1) atmospheric fallout of particulates from industries and vehicle exhaust; (2) non-point source runoff, including oil and grease from automobiles and machinery, pet wastes, lawn/garden fertilizers and insecticides; (3) wastewater discharges; (4) placement of contaminated fill material; and a variety of other sources. Sediment and surface water quality within the Hackensack River are discussed in Section 6.3, and effects on the regional environment are discussed in Sections 6.4 and 6.6.

6.7.2 Empire Tract

Due to its location within the HMD, the Empire Tract is subject to water, air and soil pollution from the various regional sources noted above. However, historically the Empire Tract has been and is presently undeveloped, consisting primarily of wetlands. No potential sources of contamination have been identified on the Empire Tract itself. To address potential contamination issues, an information review and field reconnaissance of the site and its vicinity were conducted. The review and reconnaissance are referred to as a "Phase I Environmental Audit". The objective of such an audit is to determine if there is sufficient evidence to warrant additional investigation of a site for sources of contamination. During the audit, sediment and surface water quality samples were collected in the creeks on site (see Section 6.3). Soil samples within the wetland and filled areas of the Empire Tract were not taken, nor are they required by state regulations unless there is evidence of discharge or petroleum odor etc. (Brian Moore, NJDEP, personal communication, 2001).

On the basis of the audit, no potential sources of hazardous contamination were identified on the Empire Tract. The closest potential source identified is located 0.1 mile from the site. As a result, the likelihood of significant hazardous contamination (i.e., one posing a human health risk) being present is found to be low.

6.7.2.1 Information Review

A variety of historical information sources were examined by the applicant's consultant (TAMS 1998). These included:

- Sanborn fire insurance maps indicating businesses present in the areas from 1917 through 1968;
- Aerial photographs of the area from 1953 through 1985;
- Street maps dating back to 1913; and
- Environmental Database search of public agency records.

These records are typically reviewed in a Phase I site audit.

Sanborn Fire Insurance Maps

The 1917 fire insurance map indicates some industrial activity to the north of the subject property along Mehrhof Road. Subsequent maps dating up to 1968 show increasing industrial development over former agricultural lands in adjacent upland areas along Washington Avenue and Paterson Plank Road. No industries or commercial facilities are shown on the Empire Tract on these maps. A review of available information indicates the Empire Tract has been historically vacant and undeveloped since at least the early 1900s. This is not unexpected since the majority of the site consists of wetlands. The only documented uses of the site are the Transco gas pipeline, which crosses the northeastern end of the main parcel, and a topsoil manufacturing facility that operated on a small area on the west side of the property (Figure 6.7-1).

Aerial Photos

In addition to the Sanborn maps, aerial photos taken between 1953 and 1985 show limited development on the Empire Tract. A portion of the Empire Tract on the eastern side of the New Jersey Turnpike is bordered by waterfront development. This waterfront property along Outwater Place, near the southern tip of the Tract, has been occupied by small buildings and piers since the 1950s. In addition, the Transco maintenance facility and one of the two existing aboveground natural gas storage tanks were constructed during the 1960s adjacent to this portion of the Empire Tract. Photos from the mid-1970s show the completed New Jersey Turnpike Western Spur as well as the Meadowlands Sports Complex, located southwest of Paterson Plank Road.

Empire Tract Features

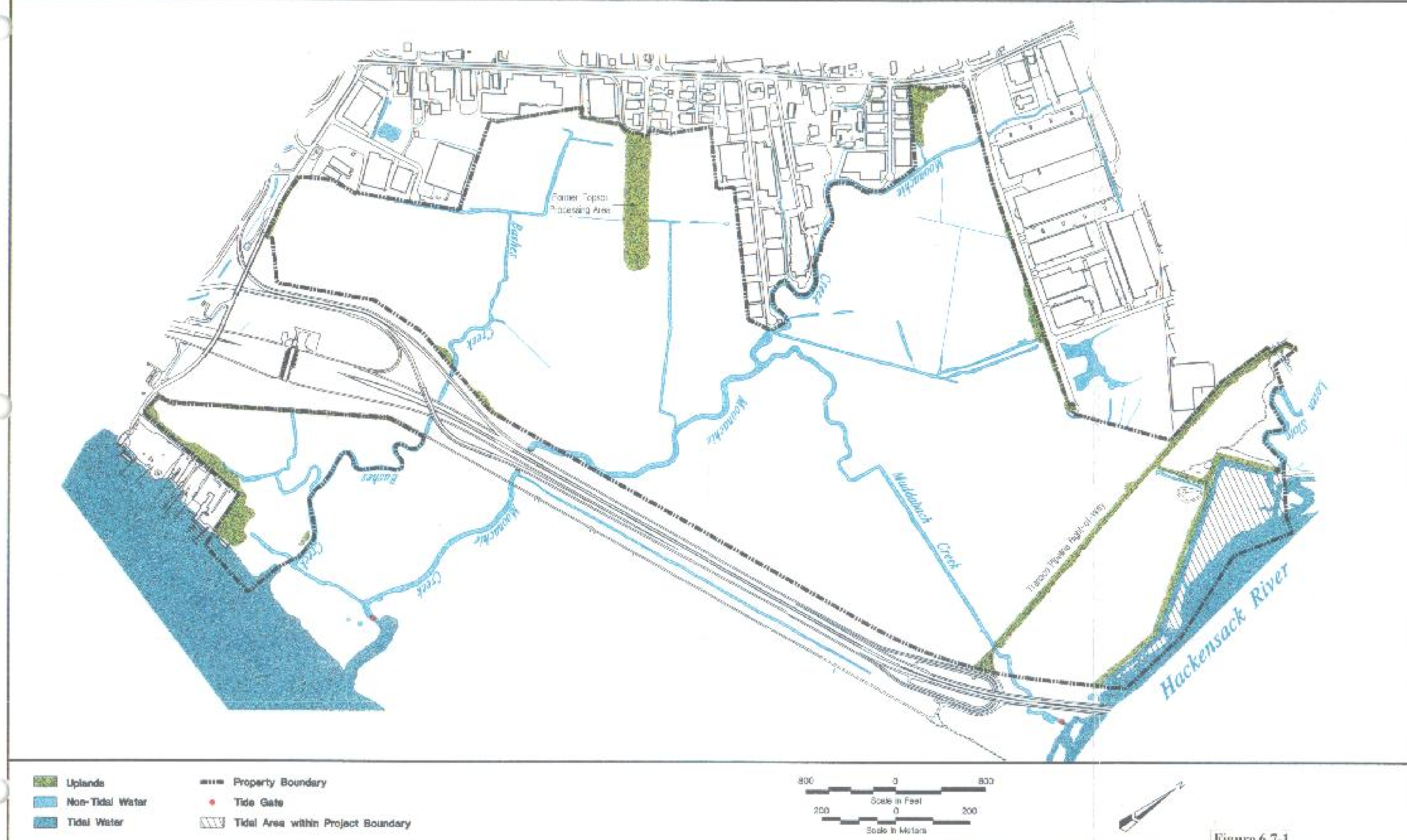

Figure 6.7-1

Street Maps

Historical street maps reviewed did not indicate any streets mapped on the Empire Tract.

Environmental Database Search

A compilation of information from federal and state environmental record sources was prepared by Environmental Risk Information and Imaging Services (ERIIS) on September 26, 1997, in accordance with the American Society of Testing and Materials (ASTM) *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (E1527-97). The objective was to determine whether there existed any records of industries or other potential hazardous contamination sources within the vicinity of the site that could potentially impact the site. The ASTM standard search area used is a 1-mile radius for certain potential hazardous contamination sources, such as Federal Superfund sites, and a 0.5-mile radius for other potential sources, such as state solid waste disposal facilities.

From the database search results, a total of 117 pertinent records were reviewed (TAMS 1998a). Records are summarized in Table 6.7-1. Records relating to sites east of the Hackensack River were not considered, since the river is expected to function as an effective hydrologic barrier to contaminated groundwater flow (TAMS 1998). However, such sites could indirectly influence the Empire Tract by affecting the regional environment (e.g., air and water quality). Additional information on sites warranting further review due to their potential to impact the Empire Tract was obtained by directly contacting NJDEP case managers (TAMS 1998).

Table 6.7-1
Summary of Records Found in Each Regulatory Database

Database, Latest Update of Data	Search Distance (miles)	Total Mappable Sites
United States Environmental Protection Agency (USEPA) National Priorities List (NPL), June 1997	1	1
USEPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) List, June 1997	0.5	3
USEPA No Further Remedial Action Planned Sites (NFRAP), April 1997	0.5	3
USEPA Resource Conservation and Recovery Information System (RCRIS) Permitted Treatment, Storage, and Disposal (TSD) Facilities Corrective Action (CORRACTS) List, April 1997	1	0
USEPA RCRIS TSD Facilities Non-CORRACTS List, April 1997	0.5	0
USEPA RCRIS Large Quantity Generators (LG), April 1997	0.25	24
USEPA RCRIS Small Quantity Generators (SG), April 1997	0.25	9
USEPA Emergency Response Notification System (ERNS), June 1997	0.25	0
NJDEP Known Contaminated Sites (HWS) Report, January 1997	1	30
NJDEP Leaking Underground Storage Tank (LRST) Incident List, November 1996	0.5	18
NJDEP Underground Storage Tank (UST) Database, May 1997	0.25	29
NJDEP Solid Waste Facility (SWF) Directory, June 1997	0.5	0
	Total	**117**

Source: ERIIS Database Search conducted by TAMS, 26 September 1997.

The database search and discussions with NJDEP case managers indicated no records of contamination sources on the Empire Tract (TAMS 1998). However, one potential contamination source, the J. Landau site, was identified in the vicinity of the Empire Tract. The J. Landau site is located at 665 Washington Avenue, behind the Grasshopper Diner/Lounge on the east side of Washington Avenue, about 0.1 mile from the Empire Tract. The J. Landau site is the subject of an ongoing investigation to determine potential off-site impacts resulting from on-site groundwater contamination.

6.7.2.2 Site Reconnaissance and Interviews

To augment the database search, a field reconnaissance was conducted of the Empire Tract and the surrounding area within a 0.25-mile radius on 25 March 1997 (TAMS 1998). The following potential environmental concerns were identified:

- Evidence was noted of some unauthorized disposal of household wastes, construction and demolition debris in localized areas along the Transco natural gas pipeline right-of-way on the main parcel of the Empire Tract, and in the smaller parcel located on the eastern side of the New Jersey Turnpike.

- Unauthorized disposal of approximately 10 cubic yards of cooling tower stack materials had occurred along the Transco right-of-way. These materials are suspected of containing asbestos. A burnt area, approximately 200 sq ft, was also observed along the Transco right-of-way. A fence and gate are now in place blocking the entrance to the Transco inspection road from Empire Boulevard, which should discourage unauthorized dumping in the future.

- Three aboveground storage tanks and adjacent areas of stained soil were identified in the area used for topsoil manufacturing (Figure 6.7-1). The tanks and stained soil were subsequently removed and the area was restored to the satisfaction of NJMC.

In addition to the field reconnaissance, an interview was conducted with a representative of the owner regarding site history (TAMS 1998). Results of this interview indicate that the site has been owned by Empire, Ltd. (or predecessor companies) since the early 1950s. While there are existing easements across the property for utilities, including Transco and Bergen County Utilities Authority, the land has not been used for commercial or residential purposes, with the exception of a 5-acre filled area at the end of Jomike Court formerly used for processing and storing topsoil materials.

Interviews also were conducted by telephone with local agencies and officials to search for environmental information (reports, files, etc.) regarding the Empire Tract (TAMS 1998). Agencies contacted included: Borough of Moonachie Board of Health, Police Department, and Fire Department; Borough of Carlstadt Department of Public Works, Police Department, Fire

Department, and Board of Health; Township of South Hackensack Department of Public Works, and Police Department; and Bergen County Health and Environmental Protection.

None of agency representatives contacted had knowledge of any spills of hazardous materials, or reports of spills on the Empire Tract. Carlstadt officials noted dumping of household garbage, construction debris, and old furniture on cul-de-sacs adjacent to the property and characterized dumping of construction debris and furniture in the area as an "on again - off again" problem. However, they offered no information on specific incidents. No specific information was obtained from the above interviews beyond that already available from other sources.

6.7.2.3 Field Reconnaissance of the Site Vicinity

A field reconnaissance of the J. Landau property conducted by TAMS on 20 October 1997 indicated the site is abandoned. The J. Landau sign indicated that the company was formerly a manufacturer of industrial lacquers, synthetics, and enamels. A number of aboveground storage tanks were still present on site, and evidence of at least one underground storage tank was observed. Codes written on the aboveground tanks indicated the following chemicals were stored and/or used at the site: acetone, methyl ethyl ketone, isobutyl acetate, methyl isobutyl ketone, petroleum naptha, paint, ethylene glycol and monobutyl ether.

According to the NJDEP Bureau of Environmental Evaluation, Cleanup and Responsibility Assessment (BEECRA) case manager Grace Jacob (personal communication to TAMS, October 1 and 23, 1997), the responsible party has been conducting an ongoing investigation of the J. Landau site. However, Ms. Jacob indicated the investigation was proceeding slowly, and that the extent of contamination was not yet known. Follow-up phone conversations with NJDEP BEECRA case manager Sylvia Pierce (S. Pierce, personal communications 2000, 2001, 2002) indicated that little additional work has been performed on the J. Landau property since 1997, although the property owner recently hired a new consultant to address contamination issues. According to Ms. Pierce, a remedial investigation report has been under review by NJDEP since October 2001.

Regarding the site history of the J. Landau property, a Notice of Violation (NOV) was issued by the NJDEP in November of 1997 concluding that contaminants had been discharged on the site. In December 1999, a second NOV was sent by the NJDEP to the J. Landau property owners. NJDEP representatives were unwilling to speculate as to the extent of any off-site contamination. The following information summarizes facts pertinent to groundwater contamination at the J. Landau site in relation to the Empire Tract:

- The present extent of any groundwater contamination and off-site migration remains unknown.

- Groundwater from the J. Landau site is apparently slowly flowing toward the Empire Tract in a southerly to southwesterly direction.

- The primary contaminants of potential concern generally identified in groundwater are ketones (methyl isobutyl ketone and isoamyl ketone).

- The distance from the J. Landau site boundary to the Empire Tract site boundary in the direction of groundwater flow is approximately 1,000 ft (TAMS 1998).

The aquifer below the Empire Tract is not used as a potable source and would not be used by the proposed development for potable water. Water for development would be purveyed by United Water New Jersey, formerly known as the Hackensack Water Company, and would originate from reservoirs in northern New Jersey and southern New York State.

Section 6.7 References

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6.8 ENDANGERED AND THREATENED SPECIES

6.8.1 Regional Setting

6.8.1.1 Federally Listed Endangered Species

Federally listed endangered species are those protected under the federal Endangered Species Act of 1973 (16 U.S.C. 1531 et al., and subsequent amendments). The New Jersey Department of Environmental Protection (NJDEP) Natural Heritage Program (NHP) maintains information regarding federally and state-listed endangered and threatened species. According to the NHP, "*Since data acquisition is a dynamic, ongoing process, the NHP cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of New Jersey. Information supplied by the NHP summarizes existing data known to the program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for environmental assessments.*" Assessments with field observations have been conducted of the HMD (HMDC 1992; USEPA and USACE 1995) and the Empire Tract (TAMS 1997, 1998).

According to the NHP, members of two federally listed endangered species have been recorded in Bergen County (Table 6.8-1). Both are invertebrate species: the dwarf wedge mussel (*Alasmidonta heterodon*), a freshwater mussel species, and the American burying beetle (*Microphorus americanus*). These two species were not observed on the Empire Tract during surveys conducted on the site (see Section 6.6).

6.8.1.2 New Jersey State-Listed Endangered and Threatened Species

State-listed endangered and threatened species are those species identified by the State of New Jersey pursuant to the Endangered and Nongame Species Conservation Act (N.J.S.A. 23:2A-1 et seq.) or which are federally listed. These species may not necessarily be considered endangered or threatened outside of New Jersey, but have been listed due to their declines within the state. The NHP has compiled a list of endangered or threatened species known to occur in Bergen County (letter dated August 11, 1997). This list is provided in Table 6.8-1.

Table 6.8-1
Endangered and Threatened Species of Bergen County

Federally Listed Endangered Species		
Species Name	**Common Name**	**Status**
Invertebrates		
Alasmidonta heterodon	Dwarf wedge mussel	E
Microphorus americanus	American burying beetle	E
State-Listed Endangered or Threatened Species		
Birds		
Accipiter cooperii	Cooper's hawk	E
Bartramia longicauda	Upland sandpiper	E
Cistothorus platensis	Sedge wren	E
Falco peregrinus	Peregrine falcon	E
Pooecetes gramineus	Vesper sparrow	E
Sterna albifrons	Least tern	E
Podilymbus podiceps	Pied-billed grebe	E
Buteo lineatus	Red-shouldered hawk	E
Circus cyaneus	Northern harrier	E
Ammodramus savannarum	Grasshopper sparrow	T
Melanerpes erythrocephalus	Red-headed woodpecker	T
Passerculus sandwichensis	Savannah sparrow	T
Strix varia	Barred owl	T
Mammals		
Neotoma magister	Allegheny woodrat	E
Reptiles		
Clemmys muhlenbergi	Bog turtle	E
Crotalus horridus	Timber rattlesnake	E
Clemmys insculpta	Wood turtle	T
Invertebrates		
Alasmidonta heterodon	Dwarf wedge mussel	E
Microphorus americanus	American burying beetle	E
Plants		
Amelanchier sanguinea	Round-leaved serviceberry	E
Ammania latifolia	Koehn's tooth-cup	E
Athyrium pycnocarpon	Glade fern	E
Bouteloua curtipendula	Side-oats grama grass	E
Carex haydenii	Cloud sedge	E
Carex pseudocyperus	Cyperus-like sedge	E
Carex tuckermanii	Tuckerman's sedge	E
Cercis canadensis	Redbud	E
Cryptogramma Stelleri	Slender rock-brake	E
Cypripedum reginae	Showy lady's-slipper	E
Equisetum pratense	Meadow horsetail	E
Eriophorum gracile	Slender cottongrass	E
Gnaphalium macounii	Clammy everlasting	E
Hemicarpha micrantha	Hemicarpha	E
Hottonia inflata	Featherfoil	E
Hypericum majus	Canadian St. John's-wort	E
Isotria medeoloides	Small whorled pogonia	E
Lemna perpusilla	Minute duckweed	E

E -- Endangered T – Threatened
Source: NJ Natural Heritage Program Database

Table 6.8-1 (Continued)
Endangered and Threatened Species of Bergen County

State-Listed Endangered or Threatened Species		
Species Name	**Common Name**	**Status**
Plants (continued)		
Lemna valdiviana	Pale duckweed	E
Limosella subulata	Mudweed	E
Linum sulcatum	Grooved yellow flax	E
Luzula acuminata	Hairy woodrush	E
Melanthium virginicum	Virginia bunchflower	E
Mimulus alatus	Winged monkey flower	E
Nuphar microphyllum	Small yellow pond lily	E
Poa autumnalis	Autumn bluegrass	E
Prenanthes racemosa	Smooth rattlesnake root	E
Pycnanthemum torrey	Torrey's mountain mint	E
Salix pedicellaris	Bog willow	E
Scirpus maritimus	Salt marsh bulrush	E
Scirpus torreu	Torrey's bulrush	E
Scleria verticillata	Whorled nut rush	E
Solidago rigida	Stiff goldenrod	E
Thuja occidentalis	Northern white cedar	E
Tiarella cordifolia	Foamflower	E
Triphora trianthophora	Three birds orchid	E
Trollius laxus	Spreading globe flower	E
Verbena simplex	Narrow-leaved vervain	E
Viola canadensis	Canada violet	E
Viola septentrionalis	Northern blue violet	E
Vitis novae-angliae	New England grape	E

E – Endangered T – Threatened
Source: NJ Natural Heritage Program Database

6.8.2 Empire Tract

Endangered or threatened species using or potentially using the Empire Tract were identified on the basis of field studies of fish, wildlife and vegetation conducted on the site and within its vicinity (TAMS 1997, 1998). These studies are discussed in Sections 6.2 and 6.5. On-site studies consisted of a 1-year avian census study of the Empire Tract, a 3-day fish sampling study of the Bashes, Moonachie, and Muddabach creeks, a small mammal investigation, observations of reptiles and amphibians, and benthic invertebrate studies of the creeks and adjacent marsh areas. Vegetation also was studied in order to prepare maps summarizing wetland community types.

Endangered and threatened species recorded on the Empire Tract are shown in Table 6.8-2. All of these species are state-listed, but none are federally listed.

6.8.2.1 Federally Listed Endangered Species

The two invertebrate species recorded in Bergen County that are federally listed have not been recorded on the Empire Tract. Benthic invertebrates were sampled in the site creeks and adjacent marshlands (see Section 6.6).

6.8.2.2 New Jersey State Listed Endangered and Threatened Species

During the 1-year avian study of the Empire Tract conducted by the applicant from February 1996 to February 1997, a total of 11 state-listed endangered or threatened bird species were observed on the Empire Tract (Table 6.8-2) (TAMS 1998). No evidence (e.g., nests, courtship behavior) was found that would indicate that any of the endangered or threatened bird species encountered were breeding on the site during the year it was sampled. Incidental observations of other wildlife (e.g., mammals, reptiles) were recorded during the study period, but no endangered or threatened species were encountered. Similarly, no endangered or threatened species of plants were observed during floral surveys performed on site (Empire Ltd. 1992, TAMS 1997).

Individuals of six New Jersey state-listed endangered or threatened species were observed on the Empire Tract less than five times during the 1-year avian study. These were: Cooper's hawk, osprey, peregrine falcon, pied-billed grebe, red-shouldered hawk, and sedge wren. The remaining five species (American bittern, bobolink, great-blue heron, northern harrier, and savannah sparrow) were each observed nine times or more.

The peregrine falcon (*Falco peregrinus*) is known to occur within the Hackensack Meadowlands (USEPA and USACE 1995), and was federally listed as endangered until it was de-listed in 1999.

No state or federally listed endangered or threatened species are known to breed on the Empire Tract. However, the site appears to provide potential breeding habitat for at least two state-listed threatened species (savannah sparrow, American bittern) and one state-listed endangered species (northern harrier, breeding population only) based upon habitat requirements of these species described in the literature (Bull and Farrand 1977). All three of these species have been documented as breeding or have bred in the Hackensack Meadowlands (NJAS 1999). In addition, all three species may breed in the vicinity of the site, since the 1-year avian study indicated they were documented on the Empire Tract during their respective breeding seasons.

State-listed threatened and endangered species recorded on the Empire Tract during the 1-year avian study are discussed individually below. Included is a description of "safe dates" taken from the *New Jersey Breeding Bird Atlas* (NJAS 1999). "Safe dates" reflect expert opinion regarding when a bird can safely be determined to be breeding within the state, and are indicative of the "average" breeding season throughout the state. It should be noted that these dates are generic in nature, and since breeding seasons often vary with geographic latitude, the dates may be superseded by local data.

- American bittern (*Botaurus lentiginosus*; state-listed threatened - breeding population) – A total of 10 observations of American bitterns were recorded in May, August, October, and November 1996, mostly in the wetlands (i.e., common reed marsh) habitat. No evidence of breeding was observed during the 1-year avian study. American bitterns are water birds that forage on frogs and invertebrates and prefer grassy freshwater and brackish marshes (Bull and Farrand 1977).

  The breeding season of this species in North America is generally from early May to late June (Gibbs et al. 1992), and depends to some extent upon the latitude of the location. "Safe dates" for breeding of this species in New Jersey are considered to be from May 20 to August 15 (NJAS 1999). However, birds in the New York City area were reported to breed in the first half of May (Cruickshank 1942, cited in Gibbs et al. 1992), and egg dates from Pennsylvania ranged from as early as March 3 to June 3 (Brauning 1993). Further north in Massachusetts, recorded egg dates ranged from May 1 to June 13. Given their secretive nature, and the fact that they were observed in 1996-1997 in early May, this species could potentially breed within the vicinity of the Empire Tract.

- Bobolink (*Dolichonyx oryzivorus*; state-listed threatened) – A total of nine observations of bobolinks were recorded in May and August 1996. All bobolink observations on the Empire Tract were in wetlands habitats. Bobolinks are related to blackbirds and prefer tall grass, flooded meadows, prairies, and other grassland habitat for breeding (Dobkin et al. 1988). The individuals observed are assumed to be migratory transients, since no bobolinks were observed during the midsummer-breeding period.

- Cooper's hawk (*Accipiter cooperii*; state-listed endangered) – A total of four Cooper's hawk observations were recorded in October 1996 during the fall migration. Cooper's hawks prefer forested areas (Bull and Farrand 1977), and thus are likely to use the Empire Tract only during migration.

- Great blue heron (*Ardea herodias*; state-listed threatened - breeding population) – Great blue herons are fish-eating birds that frequent marshes, lakes, ponds and rivers (Bull and Farrand 1977). A total of 12 observations of great blue herons were recorded in July, September, and October 1996. They were observed in the upland and wetland habitats, but interestingly, not in shallow water habitats. Great blue herons nest in colonies, and were not recorded as breeding on the Empire Tract during the 1-year avian study. The closest known heron colonies to the Empire Tract are approximately 3.25 miles away.

- Northern harrier (*Circus cyaneus*; state-listed endangered - breeding population) – The northern harrier is an open country raptor formerly referred to as the marsh hawk. Northern harriers have been known to breed in the Hackensack Meadowlands (Kane and Githens 1997) near lower Berry's Creek and are a common winter resident (Bosakowski 1983).

  A total of 167 observations of this species were recorded on 48 different days over the course of the 1-year avian study. The majority of northern harrier observations were in April and May 1996. While the breeding season for the northern harrier in North America is from mid-April to May (Bull and Farrand 1977), no evidence of breeding was observed on the Empire Tract during the 1996-1997 avian survey conducted by the applicant. Based on the number of observations recorded, and the fact that several occurred during the breeding season of this species, and the fact that the species is known to breed near Berry's Creek, the northern harrier probably breeds within the vicinity of the Empire Tract. The northern harrier nests in marshes, laying its eggs on a mound of dead reeds and grass (Bull and Farrand 1977). A review of literature found few documented reports of this species breeding in common reed habitat, although Dunne (1984) reported harriers nesting in common reed in New Jersey (3 of 43 nests found), and England (1989) reported them nesting in common reed on Long Island. Hecht (1951) had previously reported 11 nests found in common reed growing in association with white-top grass (*Fluminea* sp.) in Manitoba.

  Within the HMD, northern harrier populations appear to have declined in recent years. Four known nesting pairs of harriers were identified in the HMD in 1975, two pairs in 1979, and one pair (Berry's Creek) in the early 1990s (Kane and Githens 1997). At least one pair is known to have historically bred on the Empire Tract. (Kane 2002, personal communication).

The individuals observed on the Empire Tract during the breeding season could be local breeders or transients, given the home range of this species during the breeding season. For example, in the tallgrass prairie of southwestern Missouri, the nesting density in one study was 299 acres/pair, and male home ranges averaged 633 acres (Toland 1985). A pair in central Wisconsin used approximately 2,200 acres (Hamerstrom and DeLaRonde, Wilde 1973). In Manitoba, males defended 68.4 acres, centered on the nest (Hecht 1951). The hunting range of individual harriers was over 640 acres in Minnesota (Breckenridge 1935), while in Idaho, home ranges averaged 3,880 acres for males and 279 acres for females (Martin 1987).

- Osprey (*Pandion haliaetus*; state-listed threatened) - Ospreys were observed on the Empire Tract three times in late summer 1996. Osprey are fish-eating birds related to hawks and eagles, and are found near lakes, rivers and seacoasts (Bull and Farrand 1997). Within the HMD, a pair of ospreys had attempted to nest at a location several miles to the south of the Empire Tract (J. Peach June 18, 1997; verified by TAMS ecologists June, 1997).

- Pied-billed grebe (*Podilymbus podiceps*; state-listed endangered - breeding population) - Pied-billed grebes are water birds that prefer freshwater marshes and ponds in summer, but may use salt or brackish marshes in winter (Bull and Farrand 1977). A pied-billed grebe was observed in shallow water habitat in mid-April 1996.

- Red-shouldered hawk (*Buteo lineatus;* state-listed endangered - breeding population; state threatened - winter population) - This hawk was observed once on site during the fall migration, in late September 1996. Its preferred habitat is deciduous forested wetlands (Bull and Farrand 1977).

- Savannah sparrow (*Passerculus sandwichensis*; state-listed threatened) - The savannah sparrow prefers salt marshes for breeding, but also is found in grasslands and cultivated habitats (Bull and Farrand 1977; Kuhn 1998). It has declined in New Jersey due to a loss in acreage of grassland habitat as a result of natural succession and development (Knopf 1995).

  A total of 58 observations of savannah sparrows were recorded on the Empire Tract during the 1-year avian study. This sparrow was seen on the Empire Tract in the spring (April, May, and June, 1996) and again in the fall (September through December 1996). The majority of these observations were in wetlands, although the birds were occasionally seen in the upland habitat. No evidence was found (e.g., nests, fledglings, etc.) indicating that this species bred on the Empire Tract from 1996 to 1997. However, given that this species was recorded during the breeding season (June 1996), it could possibly breed on the Empire Tract or in the immediate vicinity. Savannah sparrows also were observed in the vicinity of Moonachie Creek by the New Jersey Audubon Society during both spring and fall migrations in 1995 (Kane and Githens 1997).

- Sedge wren (*Cistothorus platensis*; state-listed endangered) - A single male sedge wren was observed in common reed marsh wetland in late July 1996. The preferred habitat of this species is grassy marshes (Bull and Farrand 1977). Another sedge wren was observed during fall migration in late September 1996. Since there were only two sightings of this species, these were likely transient individuals.

- Peregrine falcon (*Falco peregrinus;* state-listed endangered) – A single peregrine falcon was observed flying over the Empire Tract on November 13, 1996 east of the New Jersey Turnpike near the Hackensack River.

  The peregrine falcon is known to occur within the Hackensack Meadowlands (USEPA and USACE 1995), and was federally listed as endangered until it was de-listed in 1999. With the assistance of reintroduction programs that have released captive birds into the wild, populations of this species have recovered in recent decades from the effects of DDT and other pesticides. The species has adapted fairly well to urbanized environments, and now nests on rooftops in Manhattan and on area bridges (USEPA and USACE 1995). Monitoring of the peregrine falcon by the U.S. Fish and Wildlife Service (FWS) will be conducted for 12 years, during which time the bird could be re-listed as endangered should population again decline. (USFWS 2000). The peregrine falcon has not been known to breed within the Hackensack Meadowlands (USEPA and USACE 1995).

Table 6.8-2
State-Listed Endangered and Threatened Species Recorded
On the Empire Tract

Endangered or Threatened Species		
Species Name	**Common Name**	**Status**
Accipiter cooperii	Cooper's hawk	E
Falco peregrinus	Peregrine falcon	E
Podilymbus podiceps	Pied-billed grebe	E
Buteo lineatus	Red-shouldered hawk	E
Cistothorus platensis	Sedge wren	E
Botaurus lentiginosus	American bittern	T
Dolichonyx oryzivorus	Bobolink	T
Ardea herodias	Great blue heron	T
Circus cyaneus	Northern harrier	E
Pandion haliaetus	Osprey	T
Passerculus sandwichensis	Savannah sparrow	T

E – Endangered
T – Threatened

Section 6.8 References

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6.9 CRITICAL HABITATS AND MARINE SANCTUARIES

"Critical Habitats" and "Marine Sanctuaries" are federal regulatory designations used to classify and protect habitats of endangered species, and to protect marine life, respectively. Neither of these designations is applicable to the Empire Tract or its immediate vicinity.

6.9.1 Critical Habitats

Section 3 of the Endangered Species Act (ESA) of 1973 (87 Stat 884, as amended; 16 USC 1532 et seq.) defines the critical habitat of *federally* listed threatened and/or endangered species as "the specific area within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection."

No federally listed threatened or endangered species have been observed on the Empire Tract and no critical habitat on the tract has been identified by the USFWS.

6.9.2 Marine Sanctuaries

Title III (*National Marine Sanctuaries*) of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), Public Law 92-532, serves to "identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance." Section 303 of MPRSA indicates that the Secretary of Commerce "may designate any discrete area of the marine environment as a National Marine Sanctuary and promulgate regulations implementing the designation..." At present, there are 12 existing National Marine Sanctuaries; however, none of these occur within the State of New Jersey. The nearest National Marine Sanctuary to the Empire Tract is the Stellwagen Bank National Marine Sanctuary, located in Massachusetts.

6.9.3 Other Federal Resource Designations

On a regional scale, the Hackensack Meadowlands has been identified by the USFWS as one of several "Significant Habitat Complexes" within the New York /New Jersey Harbor area (USFWS 1998a). This designation is intended to provide local, state and federal resources, planning agencies, conservation organizations, and the public with information essential to making informed land use decisions (USFWS 1998). Figure 6.9-1 shows the location of the Hackensack Meadowlands in relation to other significant habitat complexes in the New York/New Jersey Harbor area. Wetland resources in these complexes are recommended by USFWS for preservation and maintenance because of their environmental resource value on a regional scale (USFWS 1998b).

The EPA has identified all wetlands within the Hackensack Meadowlands as "EPA Priority Wetlands". Each EPA Regional Office has prepared or is developing a list of priority wetlands within its region (USFWS 1991). These lists attempt to identify the most valuable and vulnerable wetlands in the region based upon input from the Department of Interior and other agencies and organizations (USFWS 1991). The objective of these lists is to assist EPA in focusing wetland protection efforts under the Section 404 regulatory program.

Criteria for selection of EPA Priority Wetlands include the following (USEPA 1994):

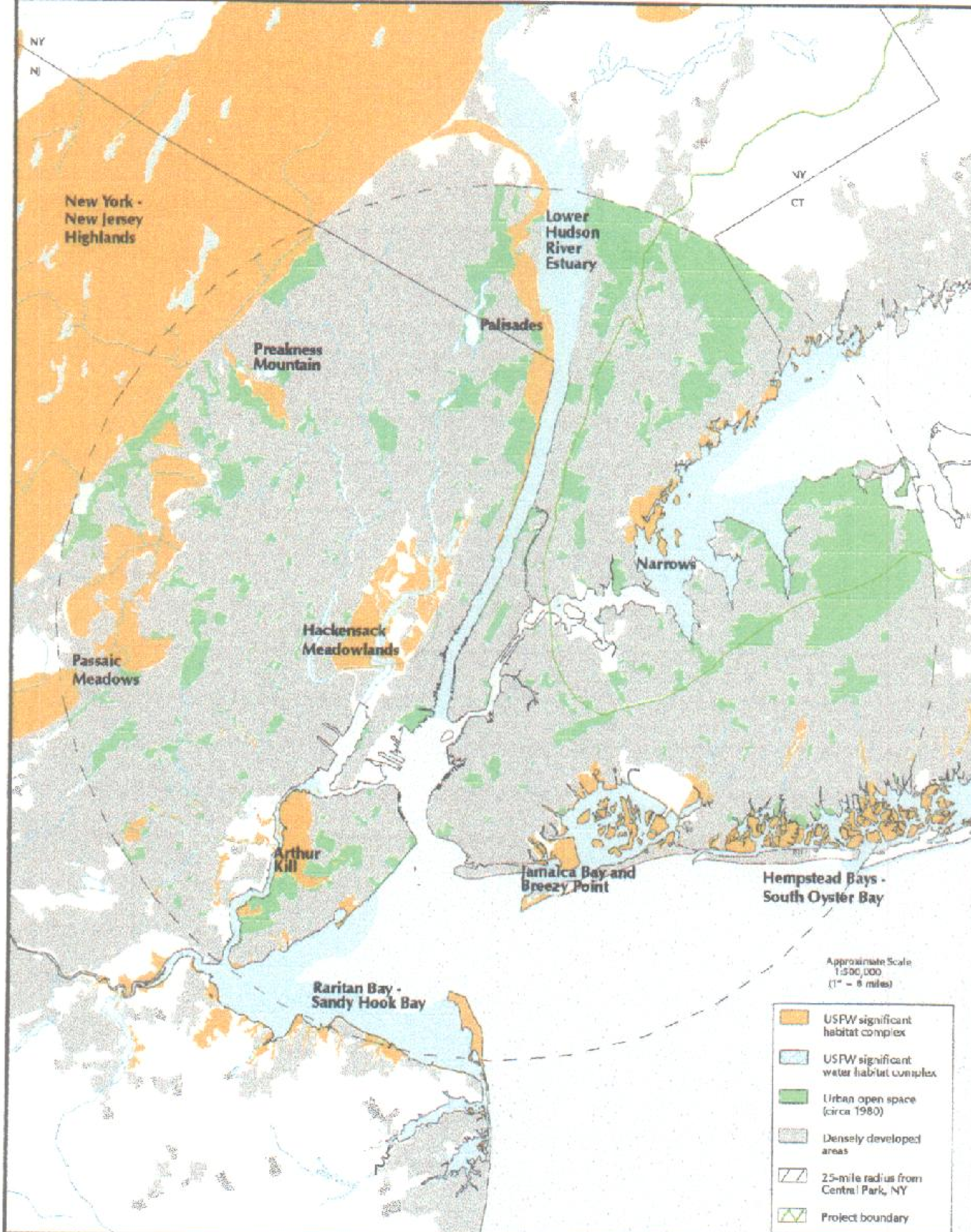
- unique habitat for fauna or flora;
- unusual or regionally rare wetland types;
- ecologically important and under threat of development;
- important to surface water systems;
- critical to protect water supplies; and
- valuable for and providing flood storage capacity.

The following resource values were identified by EPA as applicable to the Hackensack Meadowlands (USEPA 1994):

- diverse array of palustrine and estuarine wetlands;
- provides significant habitat for waterfowl, including the only New Jersey breeding population of American coots, and raptors such as the northern harrier and short-eared owl; and
- features floodwater storage for the Hackensack River and several tidal and non-tidal streams.

SIGNIFICANT HABITAT COMPLEXES IN THE NEW YORK - NEW JERSEY HARBOR AREA

Figure 6.9-1



Source: USFWS, 1998b

Section 6.9 References

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6.10 AESTHETICS

Located within the New York/New Jersey Metropolitan area, the Empire Tract is part of a larger undeveloped area along the Hackensack River, and within the Hackensack Meadowlands District. The 587-acre Empire tract comprises approximately 10% of the existing open space within the HMD. The Empire Tract is currently undeveloped, is topographically nearly flat, and is largely covered by common reed *(Phragmites australis)*. The Empire Tract is not publicly accessible.

The Empire Tract is bisected north-south by the New Jersey Turnpike's Western Spur. The site is presently visible to motorists from the southbound portion of the New Jersey Turnpike (NJTP) western spur as a large area of vegetated open space to the west of the roadway. The bridge that carries the NJTP over the Hackensack River permits extensive views of other features of the Empire Tract such as site creeks.

To the west, the Empire Tract abuts the eastern edge of existing commercial/industrial development in the Borough of Carlstadt. This development extends 2 miles west from the site to Route 17, and then runs northeast southwest at the foot of the ridge on which the residential section of Carlstadt is located. The commercial/industrial development at several locations east of Washington Avenue is visible from the site. These warehousing and manufacturing facilities are typically large, single-story structures built over the past three decades.

Immediately to the southwest of the Empire Tract are the facilities of the Meadowlands Sports Complex, with its visually dominant Giants Stadium, the Continental Airlines Arena, and the grandstands of the Meadowlands Racetrack. The other notable visual landmarks in the vicinity of the site are the approximately 140-foot-tall twin Transco natural gas storage tanks, located to the east of the Empire Tract between the New Jersey Turnpike and the Hackensack River. To the north and the east, portions of the property extend to the Hackensack River that flows north to south through the HMD. As with the Empire Tract, the adjacent undeveloped areas are predominantly vegetated by common reed (Figure 6.10-1).

Views from the Empire Tract to the east show the midtown Manhattan skyline, interrupted by the immediately proximate Transco tanks, and the Palisades ridgeline on which the communities of North Bergen and West New York are located. The commercial/industrial section of Carlstadt limits views to the west. Further to the west, the residential section of Carlstadt appears as a low-rise community on a wooded ridge that reaches an approximate 200-ft elevation.

Aerial View of Site from North

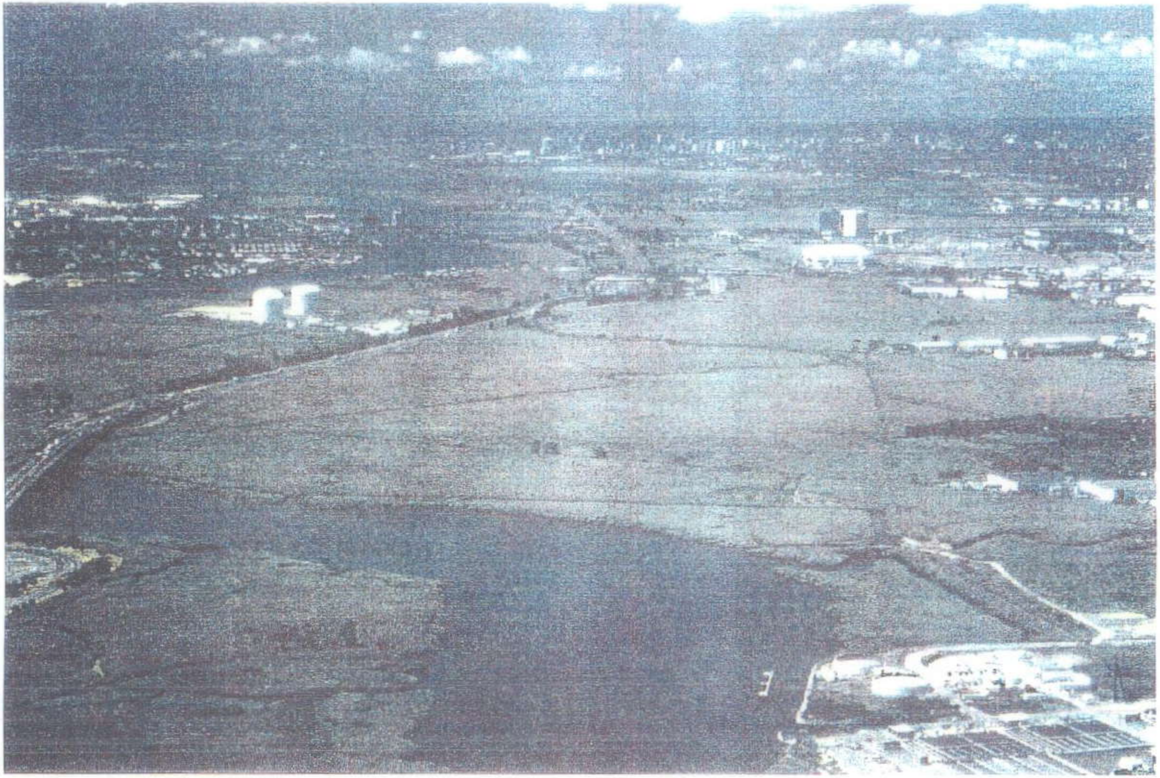

Figure 6.10-1

6.11 CULTURAL RESOURCES

6.11.1 Regional Cultural History

The archaeological record of the area can be divided into five time periods of cultural history (USEPA and USACE 1995). The Paleo Indian Period (c. 10,000-8000 BC) represents the earliest known human occupation of this area. The Archaic Period (c. 8000-1000 BC) refers to a time prior to the introduction of horticulture and the production of ceramic vessels and is further divided into early, middle, and late periods. The period from c. 1700-1000 BC is referred to as the Terminal Archaic and represents a gradual change in Archaic lifestyles and the development of Woodland Period traits. The Woodland Period (1000 BC-1600 AD) was the time of ceramic vessel use by prehistoric people and the establishment of horticulture. The Contact-Early Historic Period (AD 1600-c. 1700) was the time of Indian dominance of the region and extensive Indian contact with European settlers, traders, and travelers. The Post-Contact Period (1700-Present Day) represents the period of expanding agricultural and economic development. Each of these time periods is described below.

6.11.1.1 Paleo Indian Period (c. 10,000 BC-8000 BC)

The Paleo Indian Period includes the time from the final retreat of the Wisconsin glacier from the region to the development of modern Holocene environments. Following deglaciation, the landscape consisted of tundra-like vegetation including sedges, mosses, and lichens. This landscape was succeeded by open vegetation characterized by a mosaic of grasslands and coniferous forests. Initially, the climate was wet and cold, but gradual warming occurred, resulting in the expansion of boreal forests. Faunal species such as mammoth, mastodon, caribou, giant beaver, elk, moose, peccary, bear, and horse were present in the region and potentially available for exploitation by early Paleo Indian hunters (Funk 1972; Eisenberg 1978). Many of these animals are now extinct. The Paleo Indians were hunter-gatherers who roamed widely in search of food, and their settlement pattern consisted of small, temporary camps. These people traveled in single or multiple family bands and some evidence of their presence in the region has been found.

6.11.1.2 Archaic Period (c. 8000 BC-1000 BC)

During the Archaic Period, a major shift occurred in the settlement and subsistence patterns of Native American groups. Hunting and gathering were still the basic ways of life during this period, but emphasis in subsistence shifted from the large faunal species, which were rapidly becoming extinct, to smaller game and plants of the deciduous forest. The settlement pattern of the Archaic people indicates larger, relatively more permanent habitation sites. These people were more efficient in the exploitation of their environment, and plant food resources along with fish and shellfish played increasingly important roles in their diet. Numerous Archaic Period sites have been found in northern New Jersey in various environmental settings (Kraft 1982:60-

67). These sites vary in size and length of occupation, and were focused on the procurement and processing of subsistence resources.

6.11.1.3 Woodland Period (C. 1000 BC-1600 AD)

Woodland Period sites also are numerous in northern New Jersey, occurring on well-drained soil both inland and along the coast.

The Woodland Period is distinguished from the Archaic Period by the introduction of ceramic vessels. Although the hunting and gathering patterns persisted, horticulture developed during this period and soon became well established. Clay pottery vessels replaced the soapstone bowls, and tobacco pipes and smoking were adopted. The bow and arrow replaced the spear and javelin during this period. The habitation sites of the Woodland Period Indians increased in size and permanence, and base camps were located on expansive floodplains.

6.11.1.4 The Contact Period (C. 1600 AD-1700 AD)

The settlement of New Amsterdam (New York) by the Dutch in the early 1600s initiated the Contact Period between the Indians of northern New Jersey and Europeans. The Native Americans of northern New Jersey were part of the widespread Algonquin cultural and linguistic stock (Goddard 1978a, 1978b). In the Eighteenth Century, European settlers encountered Algonquin descendants, remnant bands of Native Americans known as the Minisinks, the Hackensacks, and the Tappans (Kraft 1986:XVIII).

Following the settlement of New Amsterdam, a regular pattern of Indian/European trade developed and the Indians began to acquire European-made tools and ornaments. This trade increased and continued. Items of European origin would, presumably, occur with greater frequency at Indian sites. However, the Contact Period is an enigmatic one in the archaeological record of northern New Jersey because few Indian archaeological sites that clearly date to this period have been found. No Contact Period archaeological sites have been found in the vicinity of the project area (see Kraft 1989:77-102; Lenik 1989:103-120).

6.11.1.5 Post-Contact Period (1700 - Present Day)

Colonial land transaction documents indicate a greater economic interest in the Meadowlands than their present day environment might indicate. In the Seventeenth Century, the Hackensack Meadowlands were mostly undisturbed. Primary colonial settlement was east and south of this area. Once the town of Bergen was formed in what is now Jersey City, the Meadowlands became an exploitable resource.

Early attempts to use the land for agricultural purposes were restricted to the eastern bank of the Hackensack, but the western bank also was patented for land sales. The Empire Tract lies within the boundaries of the 1669 Berry Patent. Early settlement within this patent was along the highest ground. This settlement pattern was typical in the Meadowlands in the Seventeenth and Eighteenth centuries. The riverine lowlands settlements were exploited for resources but not used as areas of habitation. However, the riverbank area was not ignored. Since the Hackensack River was navigable to the head of tide at New Milford, transportation of goods by water was well established.

A 1776 map by Robert Erskine, surveyor general to General Washington, depicted the Hackensack Meadowlands as a vast open area with a small cedar swamp and a narrow salt marsh along the Hackensack River. One road crosses this area between the Passaic and Hackensack rivers, running through the cedar swamp, from the Belleville area to the town of Bergen. The Schuyler family home and copper mine are shown, as is the Kingsland homestead, which still stands in present day North Arlington (FWP 1939:543). No features are shown within the project area.

The Thomas Gordon 1828 map depicts changes wrought by 52 years of progress. The area of marsh has expanded, and the number of roads crossing the region has increased. The map identifies the Paterson Plank Road, which was built in 1816 (F WP1939:421). This road was a 15-mile continuation of the Paterson-Hamburg Turnpike, which ran west from Paterson to Hamburg. This new section ran east from Paterson to Hoboken, crossing the Hackensack River at what is now Carlstadt. Paterson Plank Road passes immediately west of part of the Empire Tract. The wooden planks were replaced at a later date with stone cobbles (FWP 1939:540). A stretch of this stonework is visible in the roadway just west of the 42-acre parcel of the Empire Tract that is east of the New Jersey Turnpike. Aerial photo evidence reveals that the Paterson Plank Road Bridge was removed between 1935 and 1941 (Grossman 1995: Chart). The bridge abutments are outside of the Empire Tract.

In the Nineteenth Century, the Meadowlands were regarded as both a barrier to commerce and an area of great potential for development. Civil engineers took on the challenges of modifying the natural Meadowlands landscape. Early in the century, improvements in road-building technology had breached the barrier to travel. Plank roads, constructed of oak, pine, hemlock, tamarack, walnut, and cedar planks, provided firm yet resilient surfaces for wagons, coaches, and horses. A typical plank road used sleepers, or rails upon which the planks were placed. The finished road was covered with sand and wood shavings and ditched for drainage (Sloane 1995:68-69). New technology in water transportation also breached the Meadowlands. The Morris Canal, completed in the 1830s, ran to the south of the Hackensack Meadowlands in the Newark marshes, opening up additional east-west transportation between the interior of New Jersey and a growing New York City. Early railroads crossed the Meadowlands. A map by J. L. Sullivan, drawn in 1829, shows the proposed route of the Paterson and Hudson Railroad from Paterson to the Hudson River (Grossman 1992:28).

In the late Nineteenth and early Twentieth centuries, a greater challenge than crossing the

Meadowlands was the concept of draining and restoring them to productive, useful land. It was believed that if the wetlands were not converted to useful land, New Jersey would be perceived as a backward land of swamps. Iron dikes and other drainage techniques were used to drain the area.

Examination of historic map resources provided no evidence of structures within the vicinity of the Empire Tract until the 1902 Robinson & Company *Map of Bergen County, New Jersey*. Two buildings, each marked "Hotel," are shown near the water, one east of Paterson Plank Road and one west of the road. Both stood outside of the area of the project presently proposed; neither exists today.

The presence of road and bridge most likely increased boat-landing traffic at this point on the Hackensack River from 1816 forward, but no Nineteenth Century maps available depict any docks or other boat-related structures here.

Twentieth century development includes docks, marinas, boathouses, and Outwater Place. This road first appears in 1924 and is called Boathouse Road (Grossman 1994:PDA 5 Chart). It is related to the development of a dock and a marina area at the foot of the Hackensack River Bridge in the 1920s. Many of the boathouses, some now converted to dwellings, and much of the dock area still remains.

6.11.2 Previous Cultural Resources Research in the Project Area

Little research had been done on prehistoric human use and occupation of the Hackensack Meadowlands until the development of this area began in the 1970s. The assumptions that the area had seen little change for thousands of years and that the present environmental conditions had been prevalent well back into the prehistoric era placed a low priority on Meadowlands-specific prehistoric archaeological research. The area was regarded as an environment that would support hunting, fishing, and gathering of plant materials, but would provide no long- or short-term habitation sites.

Work by Grossman & Associates in 1992 summarized earlier efforts to reassess conditions in the area and offered a re-evaluation of the archaeological potential of the Meadowlands. Current understanding of environmental change in the Meadowlands indicates the possibility of human habitation or land exploitation. "As recently as one to two thousand years ago, [this land] may in fact have been forested dry land that was crossed by fresh water streams" (Grossman 1992:12).

Pollen analysis adds evidence that the transition from freshwater swamp to salt water marsh may have occurred at the beginning of the Twentieth Century. The freshwater cedar swamps, which characterized the Meadowlands in early colonial accounts, were relatively new environments, becoming established about 500 years ago. Nineteenth Century ditching and diking may have retarded the conversion to tidal marsh. Early Twentieth Century use of the Hackensack River to supply water for the growing towns of Bergen County reduced the freshwater flow and allowed the tidal marsh to advance into the freshwater wetland areas. Today tidal marsh is the dominant environment of the Hackensack Meadowlands (Grossman 1995:19-22).

In 1994 the NJMC commissioned a cultural resources study of the entire Hackensack Meadowlands. This study, (*Hackensack Meadowlands Archaeological and Historical Sensitivity and Impact Evaluation* – Grossman and Associates Inc. 1994) provided archaeological information for the Meadowlands Special Area Management Plan (SAMP) Draft Environmental Impact Statement (USEPA and USACE 1995). The Grossman study has been evaluated and approved as a cultural resources management tool by the NJMC, USACE, the EPA and the State of New Jersey Historic Preservation Office (SHPO). The study identified only one area of potential cultural resources interest located within the Empire Tract. This is an area located between the Hackensack River and the New Jersey Turnpike (Figure 6.11-1), identified in the Grossman study and referred to in this report as "PDA5". The 42-acre parcel of the Empire Tract east of the New Jersey Turnpike, indicated on Figure 6.11.1 as Tract 2, lies within this potentially sensitive area.

Areas within PDA5 investigated by Historical Perspectives

The Grossman studies identified several features within PDA5 that may be affected by the Meadowlands Mills project. A series of aerial photographs and the records of the Bergen County Mosquito Commission indicate earthworks, canals, and riverbank work from 1915 through 1992 (Grossman 1994:PDA 5 Chart). These include canals within the marsh and berms and dikes along the Hackensack River. An abandoned and derelict barge was found at the edge of the Hackensack River. Local informants had no information as to its provenance, age, ownership, or former use. It appears to contain some machinery.

Two other areas of potential interest were also identified (Grossman 1992: Map A). The first area is at the confluence of Cedar Creek and the Hackensack River. A second area was identified along Moonachie Creek to the east of the 42-acre Empire Tract land parcel. Both of these areas are outside the Empire Tract.

6.11.2.1 445-acre Empire Tract Parcel West of the New Jersey Turnpike

No areas of archaeological interest were identified by the Grossman study within this area of the Empire Tract.

6.11.2.2 42-acre Empire Tract Parcel East of the New Jersey Turnpike

As mentioned earlier, this section of the proposed project area lies within an area that may be of potential cultural resources interest. While no prehistoric sites have been reported within the area, certain land features fit patterns of prehistoric land use. The Grossman report states, "The prehistoric sensitivity of the parcel (PDA 5) derived from the fact that it borders Botcher's (Boetcher's or Boss's) Creek, that it is situated adjacent to a stream confluence, and that there is a knoll, a high ground, within the parcel adjacent to tidal marshlands" (Grossman 1995:31). Field reconnaissance and the analysis of cartographic and aerial photography materials indicated that these areas might have survived destruction from historic and recent impacts (Ibid.). No construction work is proposed in this area, but it is designated as an area of wetland mitigation under the project proposal.

Cultural Resources Tracts

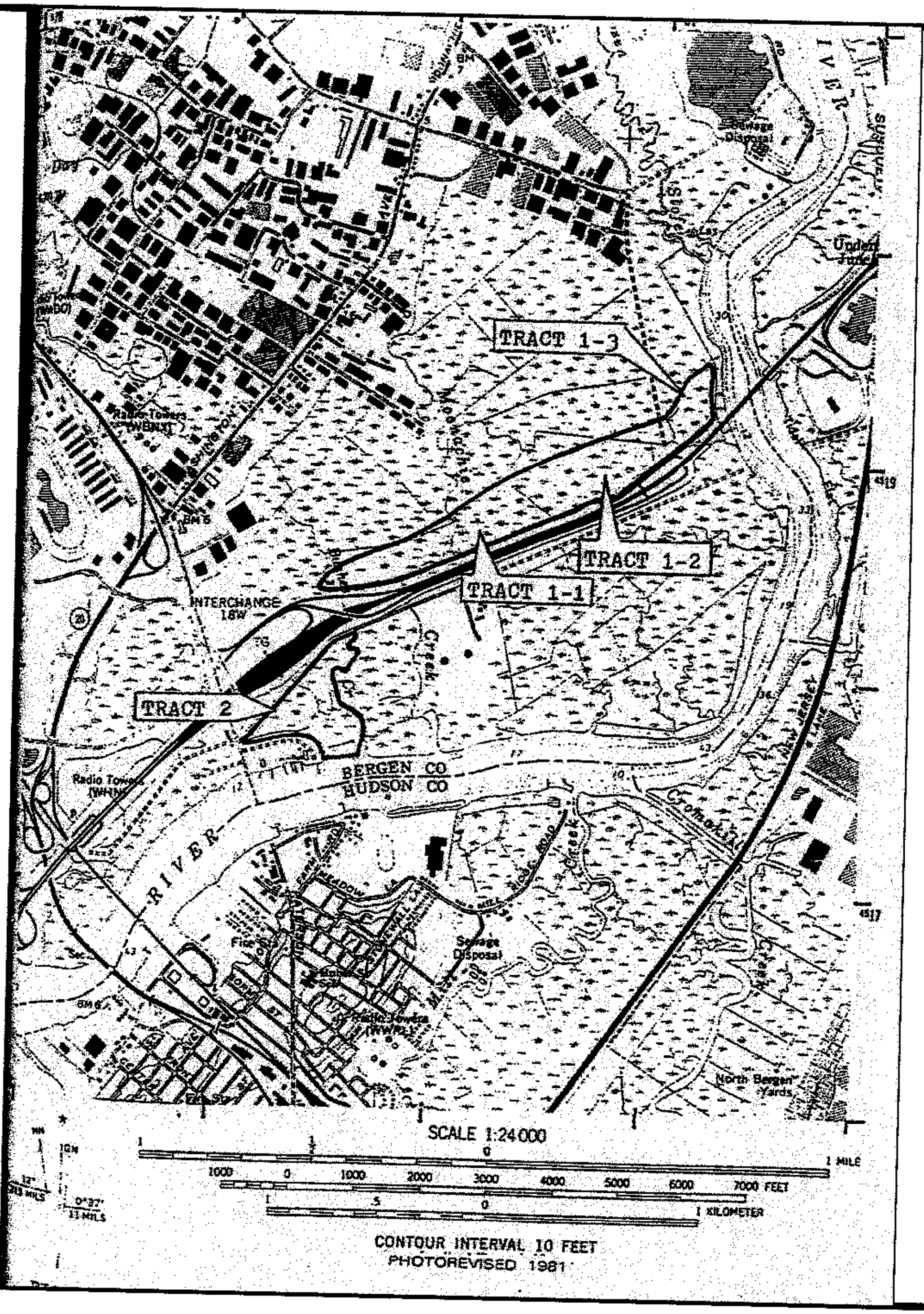

Figure 6.11-1

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6.12 TOPOGRAPHY, GEOLOGY, AND SOILS

6.12.1 Regional Setting

6.12.1.1 Regional Geology

The SAMP DEIS (USEPA and USACE 1995) described the regional geology of the Hackensack River basin within the HMD, and this description is summarized in the section below.

The Hackensack River basin is located within the glaciated section of the Piedmont physiographic province of the Appalachian Highlands. The underlying bedrock is red sandstone, siltstone, and shale of the Brunswick Formation that dates to the Triassic Period, approximately 200 million years ago. The Brunswick Formation is part of the Newark Group of sedimentary rocks. The reddish-brown arkosic sandstone, mudstone, and shalestone of this bedrock originated from nonmarine sediments deposited from the erosion of much older rocks, primarily from the Paleozoic and Precambrian ages.

The region was covered by at least three glacial advances in more recent times. The ice sheets of the glaciers moved through the Hackensack River valley, scouring and eroding the land surface and then depositing eroded material as they retreated. As a result, most of the bedrock in the area is covered by unconsolidated, glacial deposits that originated from the last advance of the continental ice sheets across the Hackensack River basin.

During the last glacial advance, Lake Hackensack was formed as the glacier began to melt and retreat northward. A terminal moraine formed a dam across the valley between the Watchung Mountain Range and the Palisades Sill. The glacial meltwaters flowing into the lake carried soil particles that were deposited on the lake bottom as relatively thin layers of sand, silt, and clay. These layers are called varves. The coarser soil particles, sands, and gravels settled out during the warmer periods of the year. During the winter, when runoff into the lake diminished, the fine-grained, suspended silt and clay particles settled out.

Typically, annual deposition resulted in one coarse-grain varve and one fine-grain varve per year. Based upon soil borings performed on the Empire Tract, the stratum of varved silts and clays is a maximum of about 60 ft in thickness beneath the site. However, there are areas in the Hackensack Meadowlands where the varved silt and clay stratum is nearly 200 ft in thickness.

At some point in time, the water levels in the ocean and lakes rose and the natural dam formed by the glacier broke, eventually draining Lake Hackensack and eroding the terminal moraine. Subsequent to the draining of the lake, a discontinuous layer of silty sand was deposited over portions of the valley. Then, with the rising ocean level, a sequence of organic deposits (peat, or "meadowmat", and organic silt and clay) was laid down as tidal marsh areas developed in the Hackensack River basin.

6.12.1.2 Regional Topography

The topography of the area encompassed by the HMD has been determined by its geological history. Because it is primarily marshland associated with what was formerly glacial Lake Hackensack, much of the HMD is nearly flat and exhibits topographic differences of less than 100 ft.

One of the most prominent natural features in the region is the ridgeline that runs through nearby Carlstadt, Wood Ridge, and Hasbrouck Heights to the northwest of the HMD, along Hackensack Street and Terrace Boulevard parallel to State Highway Route 17. In this area, elevations are about +200 ft National Geodetic Vertical Datum (NGVD). Approximately 2 miles to the east, the Palisades diabase sill rises to elevations around +250 ft NGVD prior to dropping dramatically to the Hudson River.

Most of the HMD, including the Empire Tract, lies within the Hackensack River basin located between these higher areas, and is nearly level. Also included within the basin is the town of Secaucus, the Meadowlands Sports Complex, a regional network of highways and rail, and Teterboro Airport.

6.12.1.3 Regional Soils

The soils in the region also reflect the historical geology of the area as well as recent human activities. According to the Soil Survey of Bergen County prepared by the Natural Resources Conservation Service (NRCS), most of the soils in the region are derived from glacial till and outwash (See subsection 6.12.2 for a description of these and other geologic deposits). However, throughout the project area in the northern portion of the HMD, soils have been mapped by NRCS as either tidal marsh, or as urban land. Large areas have been mapped as urban land since they have been developed with impervious surfaces or have been filled so that the original soil profile can no longer be determined.

6.12.2 Empire Tract

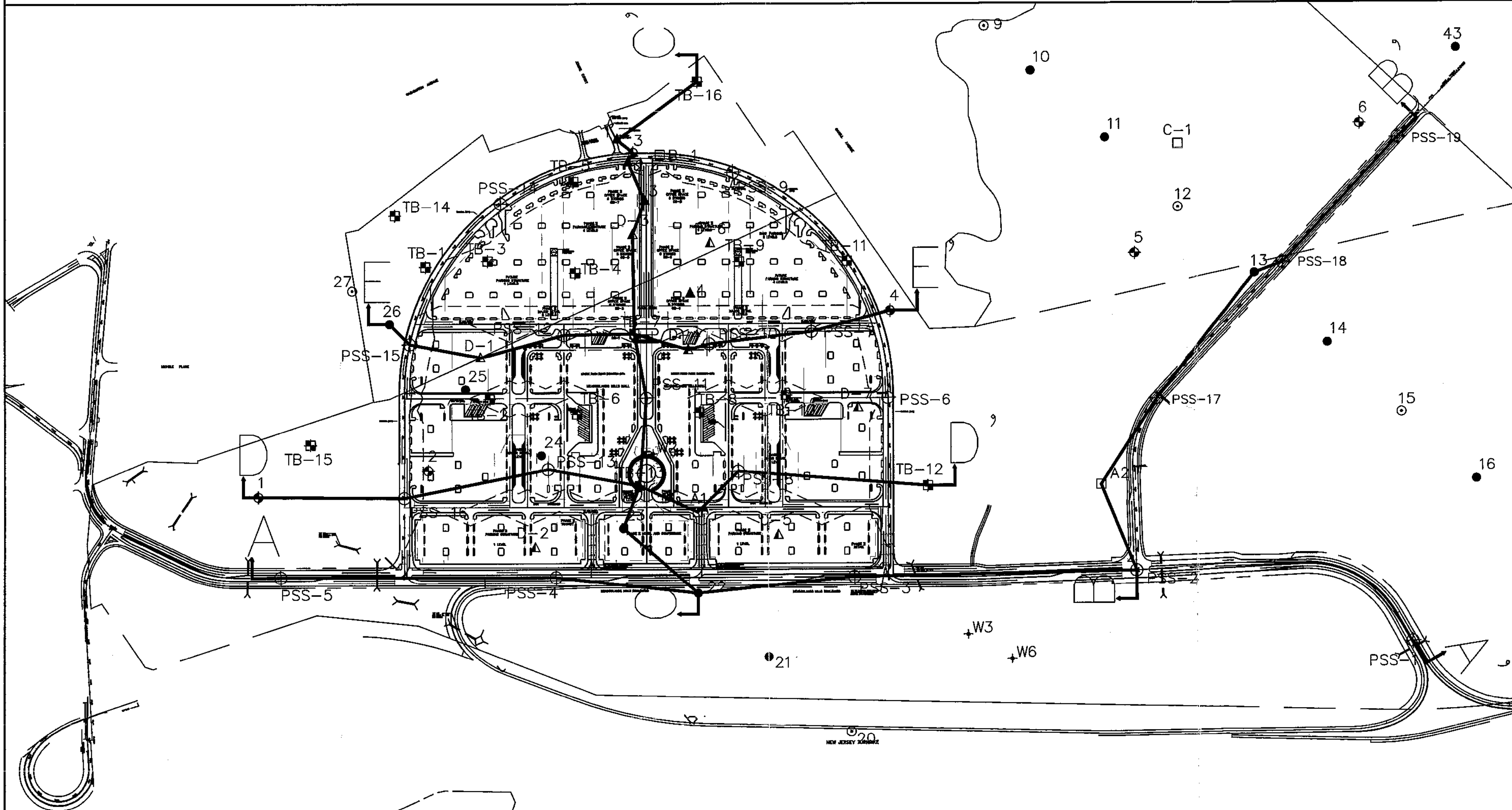
6.12.2.1 Site Geology

The site geology is the same as that described for the region in Section 6.12.1.1 above. Detailed stratigraphy of the site was determined by advancing a number of soil borings to bedrock depth (TAMS 1998). Figure 6.12-1 shows a plan view of the Empire Tract with the locations of these 147 soil borings completed on or adjacent to the site. The source of each boring is listed on the figure legend.

Based on the boring logs recorded, four stratigraphic layers were identified, from top to bottom:

- organic silt with a peat layer;

Locations of Subsurface Profiles



NOTES:

1. Note that the cross-section is not a straight line, but is drawn connecting various offset borings.
2. The Cross Sections are part of a report dated January 2000 and prepared by PS&S under Job No. 1981-0003-33.
6. For a proper understanding of the subsurface soil conditions shown on these Cross Sections, please refer to the text in the report.

GRAPHIC SCALE

300 0 150 300 600 1200

(IN FEET)
1 inch = 300 ft.

Figure 6.12-1

- varved silt and clay;
- glacial till; and
- decomposed bedrock.

Representative cross-sectional profiles of the site are presented in Figures 6.12-2 through 6.12-4.

Brief descriptions of these strata are provided as follows (TAMS 1998):

Stratum 1 – Surface Peat Layer, Peat, and Organic Silt and Clay

Stratum 1 is meadowmat, which consists of a gray-black organic soil stratum and includes peat and organic silt and clay. The peat generally contains a greater percentage of fibrous vegetation, while the organic silt and clay contains generally more decomposed organic matter in a matrix of inorganic silt- and clay-sized soil particles. This stratum ranges in consistency from very soft to soft, is highly compressible, and has a very low shear strength. These organic soils are present over most of the Empire Tract, and typically vary from 3 to as much as 11 ft in thickness. However, over much of the site the peat layer is approximately 5 ft thick. Based on the soil boring data, the organic silt with peat layer ranges from about 7 to 15 ft in thickness in the area east of the New Jersey Turnpike.

Stratum 2 - Upper Varved and Varved Silt and Clay

The gray-brown varved silt and clay stratum deposited in glacial Lake Hackensack is present beneath most of the Empire Tract. It was not encountered in a few of the borings taken in the southwestern and western portions of the main parcel. The stratum varies from stiff to very soft in consistency. Generally, if the upper 3 to 5 ft of this stratum is stiff in consistency, then the stratum becomes soft to very soft beyond that depth. The upper portion of the stratum went through a series of desiccation events and formed an over-consolidated crust layer following the natural draining of Lake Hackensack. This portion is designated as upper varved silt and clay.

Due to the shear strength and compressibility characteristics of the material, the lower portion of the varved clay layer is one of the major contributors to the overall stability and short-and long-term settlement for the proposed development.

The thickness of the entire stratum varies from 0 to about 35 ft. Beneath the western portion of the proposed building footprint the stratum is typically from 0 to about 5 ft in thickness, while beneath the eastern portion of the larger tract it varies typically from about 20 to 32 ft in thickness.

Stratum 3 - Glacial Till

The glacial till stratum is continuous beneath the Empire Tract. It is comprised of varying amounts of red-brown sand, gravel, silt and clay, and often contains boulders and cobbles. The material is typically dense to very dense. The thickness of the glacial till stratum varies from less than 10 ft to more than 30 ft.

Stratum 4 - Decomposed Shale and Bedrock

The bedrock underlying the Empire Tract is red-brown sandstone, siltstone, and/or shale. This bedrock is typically weathered and highly fractured at the upper surface and becomes sounder at depth. The top of the bedrock is approximately 20 ft below ground surface at the western end of the Empire Tract and approximately 70 ft below ground surface at the eastern portion of the proposed building footprint.

6.12.2.2 Site Topography

The existing topography of the Empire Tract is almost flat, with elevations between 0.0 and +5 ft NGVD over most of the area. Creeks and mosquito ditches meander throughout the site, adding to existing microtopography (Job and Job 1991). However, the 42-acre portion of the site located east of the New Jersey Turnpike adjacent to the Hackensack River varies in relief from 0 to +1.5 ft NGVD. This area has a small portion of uplands adjacent to the Outwater Lane embankment and the Barge Club Restaurant (shown on Figures 4.1-1). Figure 6.12-1 shows borings 29, 30 and 31 that indicate upland conditions.

Two berms are located on the tract, each running parallel with the Hackensack River. One berm on the 42-acre parcel extends from the marina at the end of Outwater Place to the tide gate at Moonachie Creek. The second berm runs adjacent to the southwest bank of a manmade channel, which carries some of the flow from the adjacent Losen Slote to the Hackensack River. The elevation of the tops of these berms varies between elevation +5 and +6 ft NGVD. These berms, and the Transco access road, range from approximately 10 to 20 ft wide at the top, and from approximately 40 to 60 ft wide at the base.

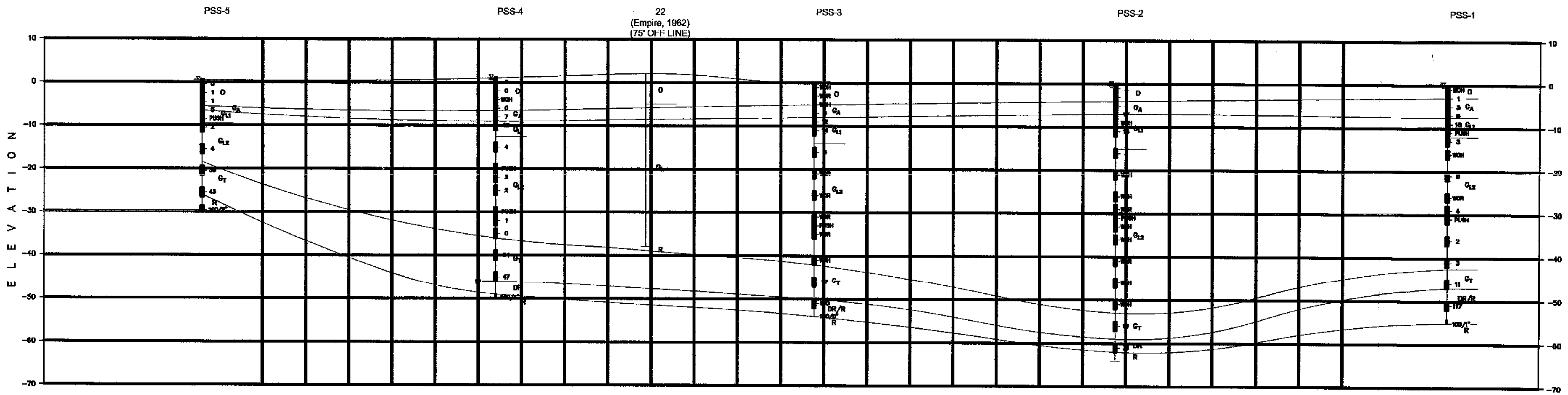
The main parcel and the 42-acre parcel are separated by the New Jersey Turnpike's Western Spur, which is elevated by an embankment extending approximately 10 ft above the on-site marsh. The elevation of the common reed marshland across the Empire Tract typically varies between elevation -1 and +2 ft NGVD.

Light industrial development is the predominant land use west of the Empire Tract. Elevations in the industrial area range from +2 ft NGVD along the site boundary to +25 ft NGVD along a small ridge located in the vicinity of Washington Avenue.

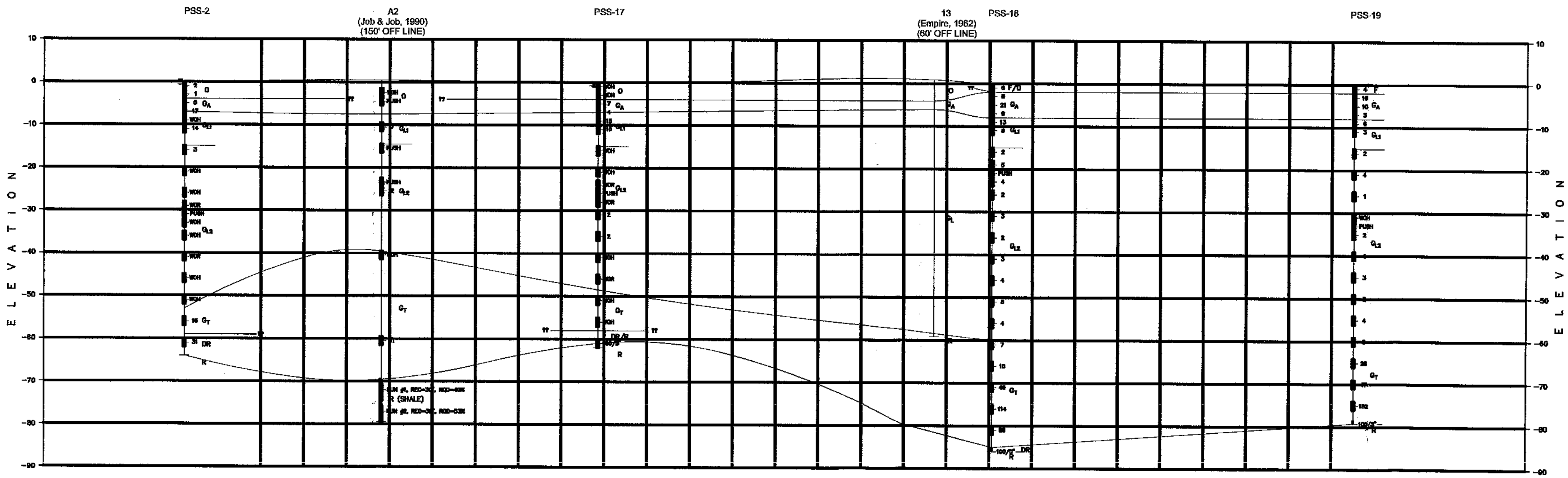
6.12.2.3 Site Soils

Soils on the majority of the Empire Tract have been mapped by NRCS as tidal marsh. The soils present over much of the Empire Tract in areas identified as wetlands have a thick surface layer of saturated organic peat up to 11 ft thick.

Subsurface Profiles



CROSS SECTION A–A
SCALE: H: 1"=100'
V: 1"=10'



CROSS SECTION B–B'
SCALE: H: 1"=100'
V: 1"=10'

LEGEND:

PSS-3 — Boring Number
— Ground Surface
Location of groundwater table.
33 — Location of disturbed soil sample and SPT "N" value in blows per foot.
WOH — Location of disturbed soil sample. Weight of hammer to advance sampler.
WOR — Location of disturbed soil sample. Weight of rods to advance sampler.
PUSH — Location of 3" diameter undisturbed soil sample.
100/3" — Location of disturbed soil sample. Only partial sampler penetration, SPT value in 100 blows per six inches or less of sampler penetration.
REC/RQD — REC = % Recovery of rock core; RQD = Rock Quality Designation of rock core
Bottom of boring

STRATIGRAPHY:

F – Fill
O – Fibrous Peat
G_A – Glacial Alluvium – Clay and Silt, w/f Sand partings
G_{L1} – Glacial Locustrine – Stiff, Silt and Clay varves
G_{L2} – Glacial Locustrine – Soft, Silt and Clay varves
G_T – Glacial Till – Sand, Silt and Clay, some Gravel
DR – Decomposed Rock
R – Bedrock – Sandstone/Siltstone/Shale

NOTES:

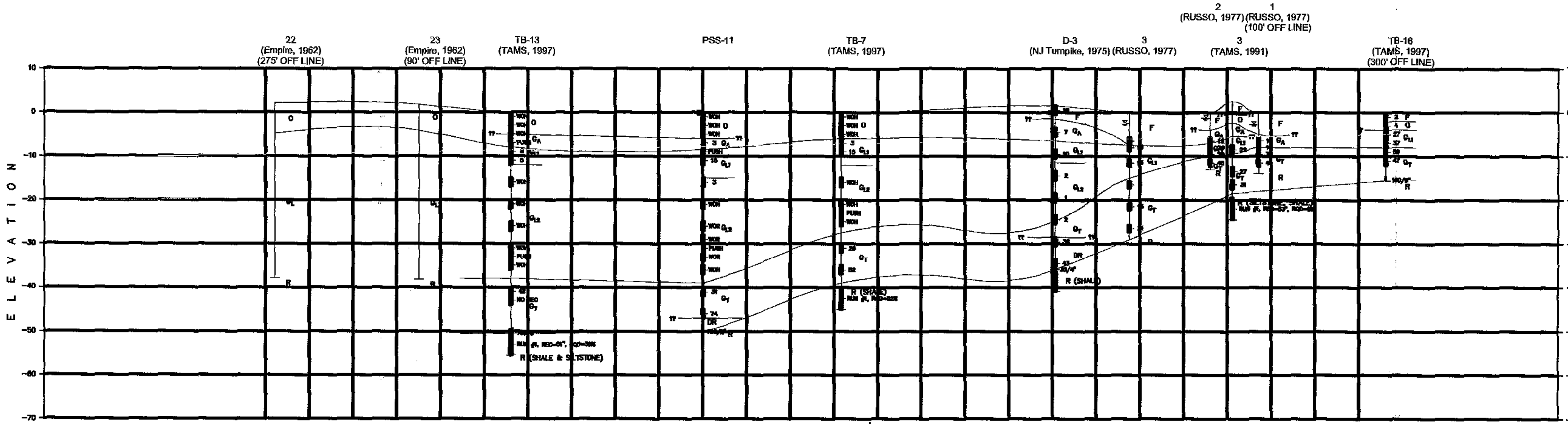
1. The locations of these Cross Sections are shown on Figure 6.12–1 Location of Subsurface Profiles. Note that these cross-sections are not a straight line, but is drawn connecting various offset borings.
2. The subsurface stratigraphy shown on these Cross Sections are the result of interpolation between widely spaced borings and vertical soil sampling intervals. Variations in stratigraphy in both the vertical and horizontal directions should be anticipated.
3. Groundwater levels were measured during the soil borings. Fluctuations of the groundwater level should be anticipated due to tidal and climatic conditions.
4. Elevations shown on these Cross Sections are based on 1929 NGVD datum.
5. These Cross Sections are part of a report dated January 2000 and prepared by PS&S under Job No. 1981–0003–33.
6. For a proper understanding of the subsurface soil conditions shown on these Cross Sections, please refer to the text in the report.

HORIZONTAL GRAPHIC SCALE
(IN FEET)
1 inch = 200 ft.

VERTICAL GRAPHIC SCALE
(IN FEET)
1 inch = 10 ft.

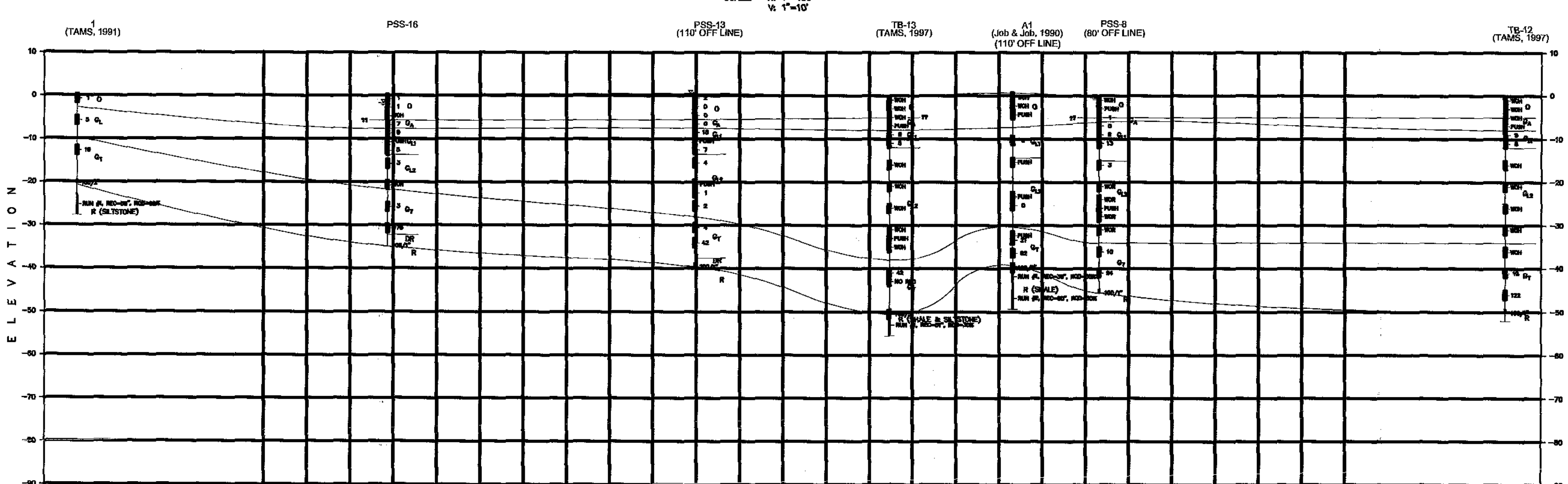
Figure 6.12–2

Subsurface Profiles



CROSS SECTION C–C

SCALE: H: 1"=100'
V: 1"=10'



CROSS SECTION D–D

SCALE: H: 1"=100'
V: 1"=10'

LEGEND:

PSS–3 — Boring Number
— Ground Surface
Location of groundwater table.
Location of disturbed soil sample and SPT "N" value in blows per foot.
WOH — Location of disturbed soil sample. Weight of hammer to advance sampler.
WOR — Location of disturbed soil sample. Weight of rods to advance sampler.
PUSH — Location of 3" diameter undisturbed soil sample.
100/3" — Location of disturbed soil sample. Only partial sampler penetration, SPT value in 100 blows per six inches or less of sampler penetration.
REC/RQD — REC = % Recovery of rock core; RQD = Rock Quality Designation of rock core
Bottom of boring

STRATIGRAPHY:

F – Fill
O – Fibrous Peat
G_A – Glacial Alluvium – Clay and Silt, w/f Sand partings
G_{LS} – Glacial Lacustrine – Stiff, Silt and Clay varves
G_{LS} – Glacial Lacustrine – Soft, Silt and Clay varves
G_T – Glacial Till – Sand, Silt and Clay, some Gravel
DR – Decomposed Rock
R – Bedrock – Sandstone/Siltstone/Shale

NOTES:

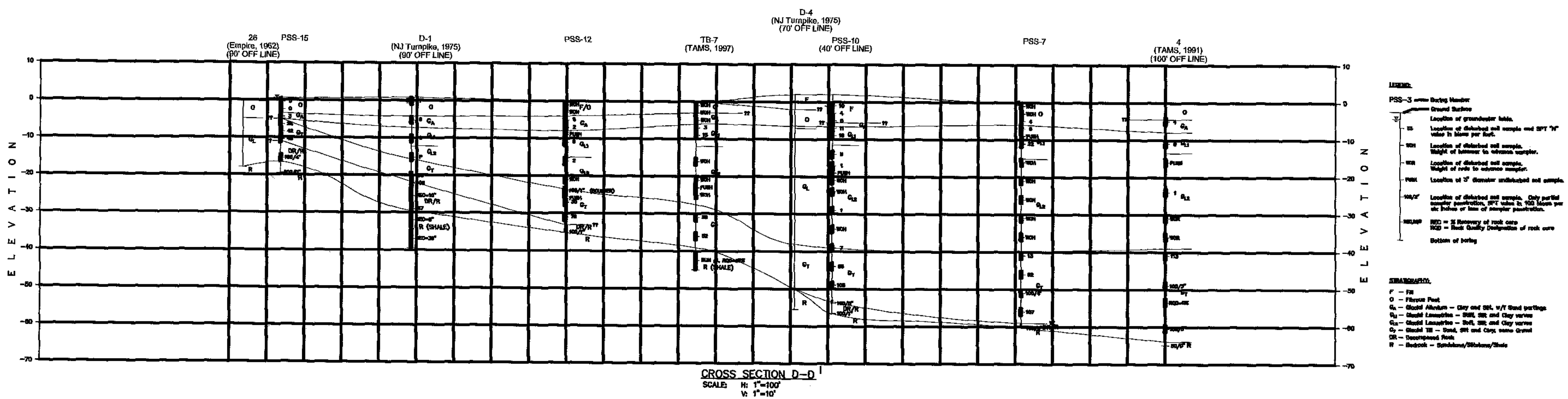
1. The locations of these Cross Sections are shown on Figure 6.12–1 Location of Subsurface Profiles. Note that these cross-sections are not a straight line, but is drawn connecting various offset borings.
2. The subsurface stratigraphy shown on these Cross Sections is the result of interpolation between widely spaced borings and vertical soil sampling intervals. Variations in stratigraphy in both the vertical and horizontal directions should be anticipated.
3. Groundwater levels were measured during the soil borings. Fluctuations of the groundwater level should be anticipated due to tidal and climatic conditions.
4. Elevations shown on these Cross Sections are based on 1929 NGVD datum.
5. These Cross Sections are part of a report dated January 2000 and prepared by PS&S under Job No. 1981-0003-33.
6. For a proper understanding of the subsurface soil conditions shown on these Cross Sections, please refer to the text in the report.

HORIZONTAL GRAPHIC SCALE
(IN FEET)
1 inch = 200 ft.

VERTICAL GRAPHIC SCALE
(IN FEET)
1 inch = 10 ft.

Figure 6.12–3

Subsurface Profiles



NOTES:

1. The location of this Cross Section is shown on Figure 6.12-1 Location of Subsurface Profiles. Note that the cross-section is not a straight line, but is drawn connecting various offset borings.
2. The subsurface stratigraphy shown on this Cross Section is the result of interpolation between widely spaced borings and vertical soil sampling intervals. Variations in stratigraphy in both the vertical and horizontal directions should be anticipated.
3. Groundwater levels were measured during the soil borings. Fluctuations of the groundwater level should be anticipated due to tidal and climatic conditions.
4. Elevations shown on this Cross Section are based on 1929 NGVD datum.
5. This Cross Section is part of a report dated January 2000 and prepared by PS&S under Job No. 1961-0003-33.
6. For a proper understanding of the subsurface soil conditions shown on this Cross Section, please refer to the text in the report.

HORIZONTAL GRAPHIC SCALE

(IN FEET)
1 inch = 100 ft.

VERTICAL GRAPHIC SCALE

(IN FEET)
1 inch = 10 ft.

Figure 6.12-4

Other portions of the Empire Tract have been filled, and are presently considered upland. In addition to the four main strata of geologic materials found on the Empire Tract described above, there are other specific geologic classification units, including off-site fill materials, silt, sand, and gravel that occur in small quantities across the site and are not continuous.

Fill material is found in small isolated areas. The fill material is comprised predominantly of soil from off-site sources, and is of variable composition and density. There are some sand, gravel, and silt layers that occur locally and over a small total area throughout the Empire Tract. When present, these layers are typically 3 ft or less in thickness. A brown sand and silt stratum was encountered in several locations along the western portion of the larger tract beneath the organic soils. The sand and silt layers vary in compactness from very loose to medium dense. This stratum contains varying amounts of silt and, at some locations, the silt is more predominant than the sand fraction of the stratum.

Section 6.12 References

Job and Job, Consulting Engineers, Land Surveyors and Planners. July 1, 1991. Topographic Survey of Empire Tract. Engineering Drawing.

TAMS. 1998. *Supplemental Additional Information Submission (SAIS).* Meadowlands Mills.

USEPA and USACE (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers). 1995. *Draft Environmental Impact Statement on the Special Area Management Plan for the Hackensack Meadowlands District, New Jersey.*

6.13 FLOODING, FLOODPLAIN VALUES, AND HYDROLOGY

6.13.1 Overview

This section focuses on existing drainage patterns of the Empire Tract and surrounding watershed that influence flooding. A general description of hydrology and its influence on wetlands and waterways was provided in Section 6.1, as well as a description of the interaction between surface water and groundwater. A description of the water budget for existing wetlands on the Empire Tract is provided in Section 6.2.

The term "floodplain" is defined by the Federal Emergency Management Agency (FEMA) as "any land area susceptible to being inundated by flood waters from any source" (44 CFR 59). The magnitude or areal extent of a flood event varies based on the intensity, duration, and type of an associated storm event. While flooding is normally associated with extreme precipitation events (referred to as fluvial precipitation events), coastal flooding caused by precipitation is exacerbated by tidal flows influenced by phases of the moon, coastal geomorphology, currents, and meteorological factors such as wind, that can affect tidal amplitude.

The magnitude or areal extent of a flood event is defined in terms of the expected recurrence interval. The recurrence interval reflects the probability that a flood event of a given magnitude will occur, and is expressed as the number of years (e.g., the 10-year storm). For example, a 10-year flood event has a 10% probability of being equaled or exceeded in any given year. A 100-year flood event has a 1% probability of being equaled or exceeded in any given year. While a 10-year flood event would probably cause a portion of the watershed surrounding the river to flood, a 100-year flood event would inundate a significantly larger area. Most rivers in this region can be expected to fill their channel to the "bankfull stage" once every year or two, but this varies with channel characteristics, substrate, surrounding land use, and precipitation.

Historically, flooding has been exacerbated by development. Development results in increased impervious cover that results in greater amounts of runoff over a shorter period of time. In contrast, natural areas such as wetlands and vegetated areas act to temporarily store flood water or allow it to infiltrate the ground. Portions of northeastern New Jersey, including the Hackensack and Passaic River basins, have suffered extensive flood damage as a result of the large proportion of impervious cover present relative to other areas in the state.

Flooding is typically mitigated with varying degrees of success by using a variety of engineering techniques, including dams, dikes, ditches, dredging, pumping systems, tidal gates, and storm water management structures. In some cases structures designed for other purposes now serve to provide some flood control function, by holding back river water. Within the HMD, many of the original wetlands were diked or drained by ditches for the purposes of mosquito control (USEPA and USACE 1995) and are of insufficient height to provide protection for large coastal storm events. Development occurred within the surrounding area, and now in some cases these berms and tide gates serve to some extent to protect surrounding municipalities from tidal flooding.

6.13.2 Regional Setting

6.13.2.1 Hackensack River Hydrology

The Hackensack River is the principal hydrologic feature within the HMD. It originates in southern New York, and extends approximately 30 miles southward before emptying into Newark Bay (WESTON 1996). The 1922 construction of Oradell Dam, located approximately 10 miles north of the Empire Tract, divided the river into two segments. The upper segment supplies freshwater to the Oradell Reservoir for use as a public water supply. In most years, however, there are 90 to 100 days when all the flow is used for potable water and no flow is discharged to the lower segment.

While its tributaries are freshwater streams, most of the flow of the lower Hackensack River is affected by saline tidal flow from Newark Bay that extends as far north as the Oradell Dam. Most of the water present within the lower Hackensack River in the vicinity of the Empire Tract originates from tidal flow from Newark Bay (see Section 6.3). Freshwater flow is provided by precipitation-induced storm water runoff, baseflow (groundwater) and direct precipitation to the lower Hackensack River.

TAMS (1998) estimated the (riverine, non-tidal) freshwater flows in cubic feet per second (cfs) in the Hackensack River within the vicinity of the Empire Tract (Table 6.13-1). Hackensack River flows at the confluence with Overpeck Creek and the confluence with Bellman's Creek were taken from the FEMA flood insurance report (FEMA 1995). The flow for the Hackensack River adjacent to the Empire Tract at Losen Slote was estimated using the gauge transfer method described in the New Jersey Technical Manual for Stream Encroachment (NJDEP 1988). This method is used to estimate flows in river reaches that do not have gauges using published data from gauged reaches.

Table 6.13-1
100-Year Fluvial Stream Flow Estimates for the Hackensack River[A]

Location	Drainage Area (sq mi)	100-Year Flow (cfs)
Confluence with Overpeck Creek (1.3 miles upstream of Losen Slote)	134.4	7,510
Adjacent to Empire Tract at Losen Slote	146.3	9,330
Confluence with Bellman's Creek (1.1 miles downstream of Losen Slote)	154.4	10,710

[A] Upstream and downstream values from FEMA FIS and Losen Slote value estimated using the gage technique.

6.13.2.2 Regional Flooding

The 100-year floodplain is the projected area that would be inundated by a flood event with a 1% chance of it being equaled or exceeded in any given year. As shown on Figure 6.1-1, much of the HMD is mapped by FEMA to be within the 100-year floodplain (Zone AE). The area mapped is based on the FIS and the Flood Insurance Rate Maps released in September 1995.

Much of the mapped 100-year floodplain lies within the natural floodplain of the river that historically flooded on a regular basis as a consequence of daily and seasonal high tides. These areas consist of flat, low-lying wetland areas at a similar elevation to the river itself (see Section 6.12). Historically, river flooding was buffered by these naturally occurring wetlands. However, since about 55% of these wetlands have been filled (see Section 6.2), the flood storage potential of the region has decreased. Moreover, development has encroached to the edges of the remaining wetland areas, making existing developed areas vulnerable to flooding during extreme storm events. The changing impact of flooding over the years is evident in the letters received from local residents by the USACE, documenting effects of flooding in the region.

Two major sources of surface water contribute to regional flooding. These are tidal flows that enter the lower Hackensack River from Newark Bay, and storm water runoff from within the watershed. Hydrodynamic modeling has indicated that tidal flows from Newark Bay contribute the most flow to the lower Hackensack River (see Sections 6.1 and 6.3). Flows from the watershed consist of freshwater, primarily in the form of runoff, but also include base flows from groundwater. Due to the developed nature of the watershed, the groundwater component is less than it would be for undeveloped areas that allow precipitation to infiltrate into the groundwater.

The watershed of the Hackensack River within the HMD has been divided into a total of 27 primary drainage basins (Figure 6.13-1) on the basis of previous hydrological studies (USEPA and USACE 1995). Table 6.13-2 lists the drainage areas for these basins as taken from the SAMP DEIS (USEPA and USACE 1995). From Table 6.13-2 it can be seen that the total drainage area of the Hackensack River within the HMD is approximately 20,555 acres, or slightly greater than 32 square miles.

The Empire/Moonachie Creek drainage basin, Subbasin 9, includes the Empire Tract. This subbasin encompasses approximately 1,125 acres, or roughly 5% of the Hackensack River watershed within the HMD. The 587-acre Empire Tract accounts for slightly more than half of the Empire/Moonachie Creek drainage basin. Most of the area within the basin, but beyond the Empire Tract property boundary, consists of developed areas with a high proportion of impervious cover. The area has been subject to extensive flooding on several occasions. Depending upon the circumstances of the individual event, the flooding can be attributed to both tidal flows from the river and/or runoff and groundwater from the watershed.

Table 6.13-2
Drainage Basins of the Hackensack River within the Hackensack Meadowlands District[A]

Subbasin	Drainage Area[B]	
	(acres)	(sq. mi.)
1. West Riser	1,016.3	1.59
2. East Riser	971.7	1.52
3. Little Ferry Street	244.3	0.38
4. BCUA/Clay Pit Pond	98.0	0.15
5. Losen Slote	311.1	0.49
6. Ridgefield/Overpeck Creek	423.8	0.66
7. Bellmans Creek	807.8	1.26
8. Peach Island Creek	277.8	0.43
9. Empire/Moonachie Creek	1,124.8	1.76
10. Transco/Doctor Creek	559.4	0.87
11. North Bergen Sheet	62.7	0.10
12. Berrys Creek North of Rt. 3	2,163.6	3.38
13. East Rutherford Sheet	298.4	0.47
14. Mill Creek	548.9	0.86
15. Paunpeck Creek	43.8	0.07
16. Cromakill Creek	688.7	1.08
17. Berrys Creek (Rutherford)	1,166.9	1.82
18. Berrys Creek Canal	517.7	0.81
19. Kingsland Island	488.7	0.76
20. Lyndhurst Sheet/MaryAnn Creek	87.7	0.14
21. Sawmill Mud Flats	696.9	1.09
22. Sawmill Creek	905.8	1.42
23. Secaucas Sheet/Anderson Creek	2,291.7	3.58
24. Penhorn Creek	1,787.6	2.79
25. Penhorn Sheet/Fish Creek	45.9	0.07
26. Kearny Marsh Drainageway	2,668.6	4.17
27. Jersey City Sheet	256.9	0.40
Totals	**20,555.5**	**32.12**

[A] Based on 1987 NJMC data presented in the SAMP DEIS (USEPA and USACE, 1995).
[B] All major roads excluded.

Drainage Basins in the Hackensack Meadowlands District

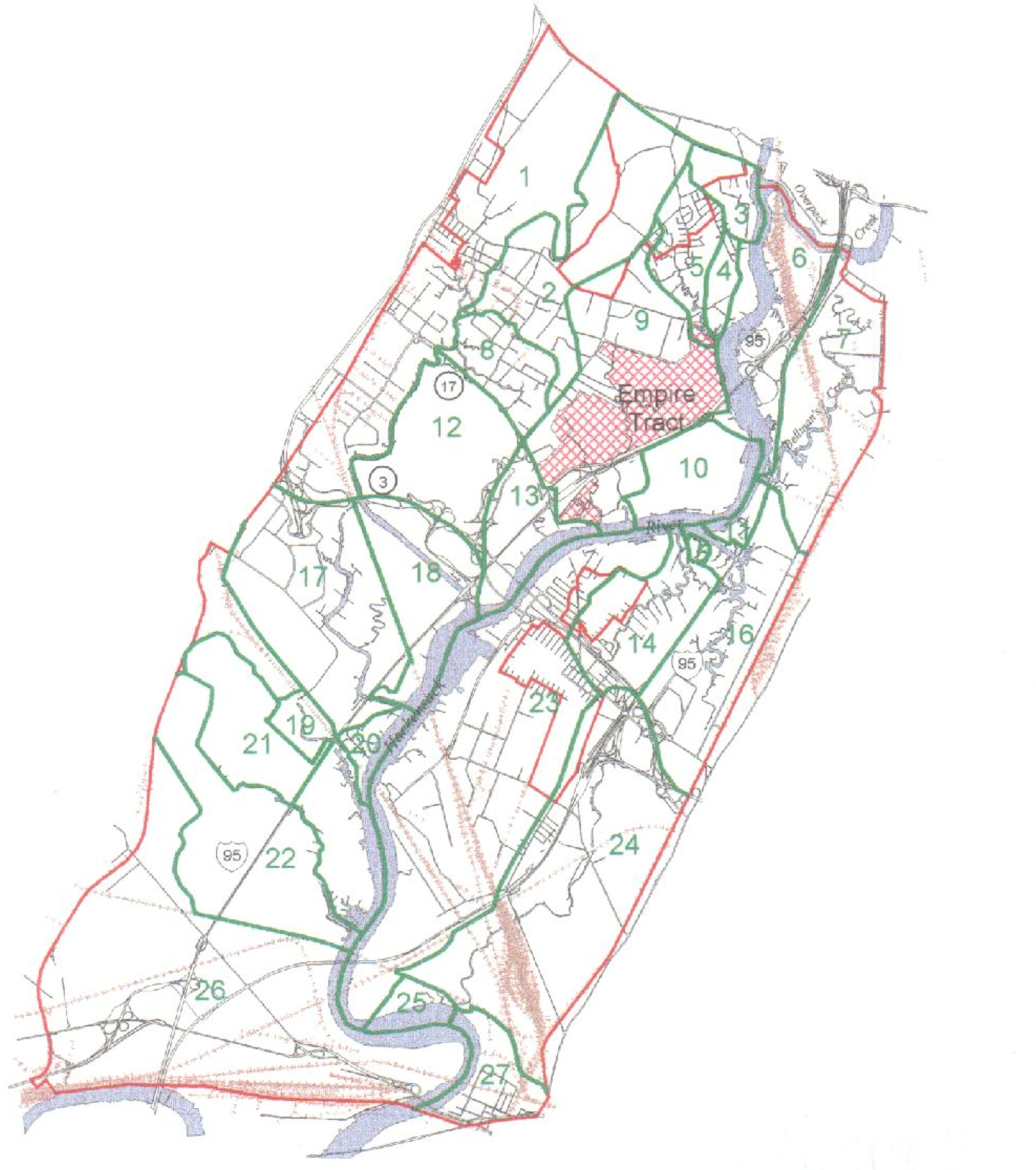


Figure 6.13-1

Source: Adapted from USEPA and USACE (1995).

6.13.3 Empire Tract Hydrology

6.13.3.1 Empire Tract Surface Water Hydrology

Surface water present on the Empire Tract originates from direct precipitation, storm water runoff from the watershed, and some tidal waters from the Hackensack River and wetlands groundwater discharge. Figure 6.13-2 shows that the upstream areas in the Empire/Moonachie Creek subbasin are intensely developed. Storm water runoff and groundwater from developed areas located northwest of the Empire Tract are transported in southerly and easterly directions across the Empire Tract towards the Hackensack River (Figure 6.13-2). As shown in Figure 6.1-2, the runoff from these developed areas flows through the Empire Tract and into the Hackensack River by three creeks: Moonachie Creek, Muddabach Creek, and Bashes Creek. The majority of the site (568 acres) is drained by Moonachie Creek, Muddabach Creek, and Bashes Creek. Fifteen acres in the northwestern corner of the Empire Tract drains to Losen Slote. In addition to the creeks, numerous smaller tributaries and irrigation/mosquito control ditches exist throughout the Empire Tract. These creeks and ditches are typically shallow (average depth less than 2 ft) but vary in width from a few feet wide to nearly 40 ft wide for Moonachie Creek (TAMS 1998).

The three creeks that traverse the Empire Tract discharge to the Hackensack River through three tide gates (see Figure 6.1-2). During the construction of a berm approximately 60 years ago, Bashes Creek was diverted to Moonachie Creek and thus flows through the tide gate of Moonachie Creek (TAMS 1998). These tide gates and berms on site (see Section 6.12) provide flood protection for the low-lying developed areas that are located upstream (east) of the Empire Tract.

The extent to which the site may flood is governed by a number of interacting factors, including amount of precipitation, duration of precipitation event, the extent of a storm surge, time of year, and the available storage capacity to absorb the water in the ground. Based on the height of the berms, flood protection is provided against daily tidal inundation and the effects of small to moderate tidal storm surges. In the case of a large coastal storm, such as a 10-year storm, floodwaters would be expected to breach the berms and cover most of the Empire Tract. Other situations, such as high precipitation coupled with unusual high tide events, may also result in flooding. Floodwaters trapped behind the berms drain from the site through the tide gates. Hurricane Floyd in September 1999 was unusual since the site did not flood. Presumably this was due to preceding drought conditions that enabled the wetland to absorb most of the water. Also, a low tide additionally allowed the water to drain from the site through the tide gates, rather than backing up.

During rainfall events, storm water runoff from the developed areas discharges into the Empire Tract via both storm sewers and overland surface runoff. The runoff is stored in the creeks that provide storage volume. The wetlands on the Empire Tract are normally not inundated during rain events. The wetlands can provide storage for major storms by inundation from creek bank overflow and from lateral movement of water in the creeks into the wetland groundwater. The surface water level in the ditches and creeks on the site is regulated by the tide gates. When the water level on the site is higher than the level in the Hackensack River (usually during a low tide condition), the water pushes the tide gate open and flows out into the river. When the water level in the river is higher than that on the site (usually during a high tide condition or a storm surge event), the water from the river pushes against the tide gate, keeping it closed and preventing river water from flowing onto the site.

The Moonachie Creek tide gate consists of a 30-inch-diameter cast iron pipe and a 36-inch-diameter corrugated metal pipe, both of which have a standard flap gate on the downstream end to act as the tide gate (TAMS 1998). Muddabach Creek also has a standard flap gate mounted on the downstream end of a 30-inch cast iron pipe. Both of these tide gates are older and river water leaks back in to the site through the gates at high tides. The Losen Slote tide gate structure was rebuilt in 1991 and does not have the same leakage problem as the other two gates (TAMS 1998).

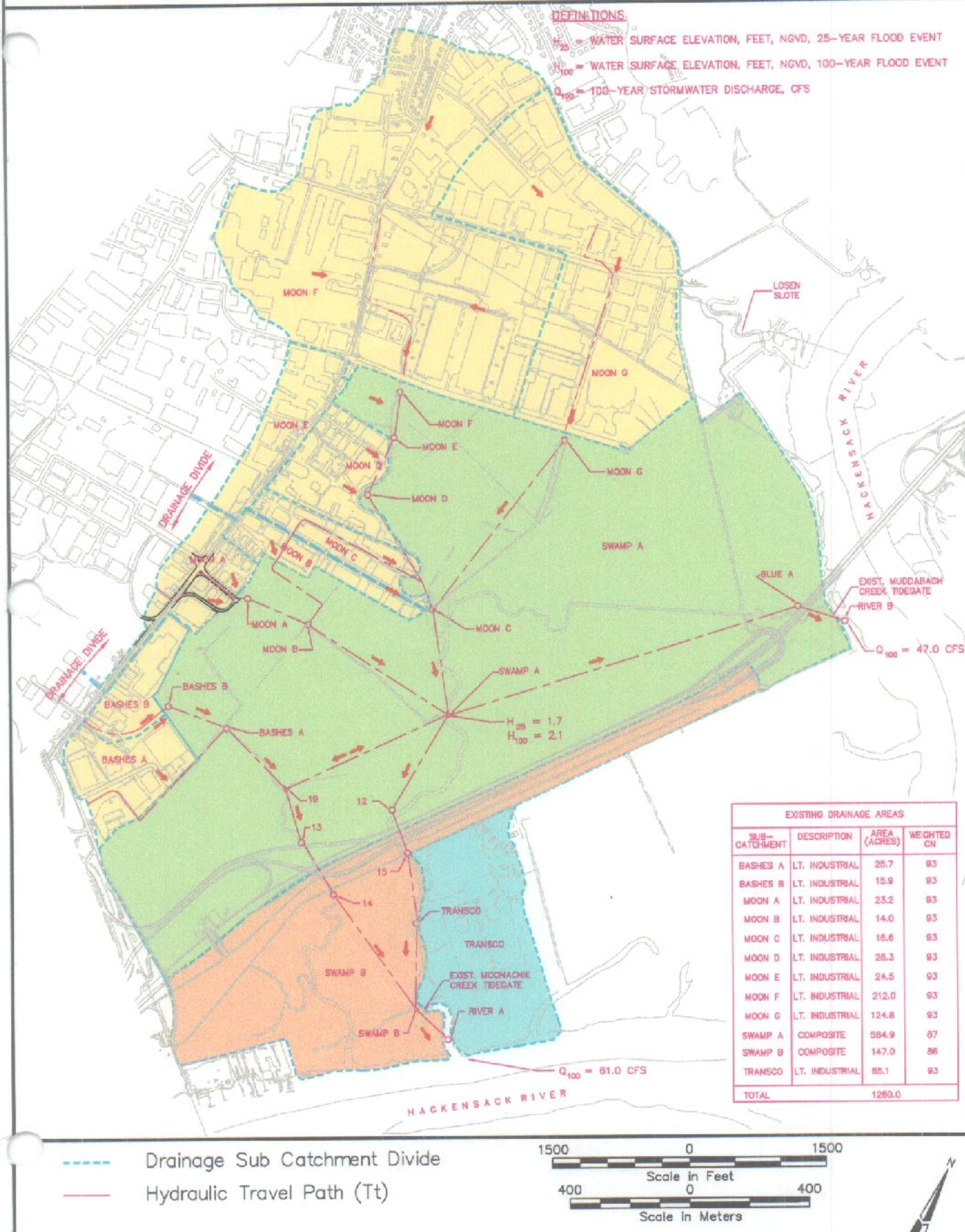
In comparison to the freshwater flow for the Hackensack River (Table 6.13-1), the freshwater flow from the Empire Tract was estimated at 137 cfs for the 100-year storm. This estimate was computed by calculating the sum of the 100-year flows from Moonachie Creek and Muddabach Creek at their tide gates using XP-SWMM dynamic hydraulic modeling software. While the model was not calibrated to observed flows, a sensitivity analysis (TAMS 2000) indicated that the model was relatively insensitive to $\pm$ 20% changes in the Time of Concentration, Shape Factor, and Manning's "n" Value. The analysis indicated that the only parameter that significantly changes the model is the curve number, which is a reflection of how much runoff would be produced by different land use cover or soil types. However, the range of logical values that could be entered into the model given the site's existing land cover is limited. The robustness of the model as demonstrated by the sensitivity analysis indicates that the model provides a reasonable representation of the existing runoff flow conditions. The 137 cfs estimate of flows from the Empire Tract (and upstream developed areas within the Moonachie Creek subbasin) accounts for approximately 1.4% of the estimated 100-year Hackensack River freshwater flow near Losen Slote. If compared to the entire flow of the river (including the tidal flow from Newark Bay), the amount of flow contributed by the site area would be significantly less.

6.13.3.2 Empire Tract Flooding

Review of Figure 6.1-1 indicates that the entire Empire Tract is located within the 100-year floodplain mapped by FEMA. The FEMA study reported that the 100-year flood elevation near the river is 9 ft NGVD, and in the inland areas of the site located west of the New Jersey Turnpike and south of the Transco pipeline it is approximately 8 ft NGVD. Table 6.13-3 summarizes predicted flood elevations for storm events of varying intensity (e.g., 10-year, 50-year, 100-year, and 500-year storms).

It is important to remember that these FEMA flood elevations are derived solely by runoff from upstream sources and do not incorporate the impact of tidal surges. For example, the "northeaster" storm of December 1992 created a tidal surge of approximately 7.3 ft NGVD that

Site and Local Watershed Conditions - Existing Conditions



EXISTING DRAINAGE AREAS			
SUB-CATCHMENT	DESCRIPTION	AREA (ACRES)	WEIGHTED CN
BASHES A	LT. INDUSTRIAL	25.7	93
BASHES B	LT. INDUSTRIAL	15.9	93
MOON A	LT. INDUSTRIAL	23.2	93
MOON B	LT. INDUSTRIAL	14.0	93
MOON C	LT. INDUSTRIAL	16.6	93
MOON D	LT. INDUSTRIAL	26.3	93
MOON E	LT. INDUSTRIAL	24.5	93
MOON F	LT. INDUSTRIAL	212.0	93
MOON G	LT. INDUSTRIAL	124.8	93
SWAMP A	COMPOSITE	584.9	87
SWAMP B	COMPOSITE	147.0	86
TRANSCO	LT. INDUSTRIAL	65.1	93
TOTAL		1280.0	

Source: Adapted from TAMS (1998a).

Figure 6.13-2

overtopped the banks of the Hackensack River upstream of Losen Slote. The New York District USACE estimated that this storm event had a recurrence interval of between 25 and 30 years. This storm resulted in flooding of portions of the Empire Tract as well as some developed areas immediately west of the site.

Table 6.13-3
Hackensack River Flood Elevations(A) Near the Empire Tract(B)

Location	Water Surface Elevation (ft, NGVD(C))			
	10-Year	50-Year	100-Year	500-Year
Adjacent to Empire Tract	6.6	8.0	8.6	9.1
Losen Slote(D)	6.6	8.0	8.7	9.1

(A) All elevations are "stillwater" elevations in that they ignore the effect of waves.
(B) Empire Tract topography ranges between 0 and 5 ft NGVD.
(C) National Geodetic Vertical Datum.
(D) Losen Slote location is approximately 5,000 ft upstream from the first location.

The berm and tide gate system provides some flood protection for areas in the Moonachie Creek drainage basin; however, variation in berm height and tide gate problems contributed to flooding problems in the past. As stated in Section 6.12, the berms vary in height between 5 ft and 6 ft NGVD. Thus, the berms and tide gates provide protection to approximately 5 ft NGVD (TAMS 1998). The 5-foot elevation is less than the 6.6-foot elevation indicative of the extent that would be inundated under a storm with a 10-year recurrence interval (Table 6.13-3). Thus, much of the Empire Tract and adjacent upstream, developed areas in the Empire/Moonachie Creek subbasin would flood during a 10-year storm.

6.13.3.3 Empire Tract Groundwater Hydrology

Groundwater under the Empire Tract is not used as a potable water source (see Section 6.3). However, the interaction between surface water and groundwater is important in understanding the water budget of existing wetlands on site, and the extent to which wetlands are hydraulically connected with the creeks on the site and with the Hackensack River (see Section 6.2). It is also important as a basis for design of the wetland mitigation plan, to ensure that sufficient amounts of water would be present to foster the growth of wetland vegetation (Sections 7.2 and 8.1). The general relationships between surface water and groundwater on the Empire Tract are described in Section 6.1, while a detailed description of the various geologic materials underlying the site is provided in Section 6.2.

Groundwater is contained within the soil pore spaces of all of the geologic materials beneath the site. The volume of water that can be stored in a geologic material depends on the soil porosity. Porosity is defined as the percentage of open pore spaces (between the soil particles) divided by a unit total volume of the material. The soil permeability is a measure of the relative ease with which water can move through the material, assuming a hydraulic gradient (driving force) exists. At the Empire Tract site, depending on the degree of decomposition, the peat has an extremely high porosity and associated absorptive capacity to receive and hold water. The deeper geologic deposits (varved silt and clay, glacial till, and bedrock) have a much lower porosity and permeability than the peat. Laboratory measurements of the varved silt and clay layer showed it to be relatively impermeable to groundwater flow.

Because of its low permeability, the varved silt and clay stratum forms a barrier to vertical movement of groundwater between the peat/organic silt layer and the deeper till and bedrock groundwater system. This type of barrier is called a "confining unit" or "aquiclude." Where present, the varved silt and clay effectively prevents interaction between the shallow groundwater system (peat/organic silt) and the deeper system (till/bedrock).

Based on data collected in 1991, 1996, 1998, 1999, and 2000, it has been determined that the upper groundwater surface (the water table) across the Empire Tract is on average 1 to 2 ft below ground surface, or between approximately elevation 0 to 1 ft NGVD (TAMS 1998, PS&S 2000a, PS&S 2001b). This water table surface lies within the upper peat/organic silt layer.

The Empire Tract wetlands appear to receive most of their water input from precipitation falling directly on the wetlands (PS&S 2000b). Site conditions are highly favorable to infiltration of precipitation into the wetlands, including a flat topography (low potential for runoff), high porosity of the peat, areas of topographic depressions where water may pond and be allowed to infiltrate, and an extensive phragmites system with highly porous root mass and vertical channels for groundwater seepage created around the plant stems. Data collected on the site have demonstrated this high potential for infiltration. Groundwater levels were observed to respond (increase) directly and immediately at the onset of a precipitation event (PS&S 2000a). This response was noted at several test wells located at various distances from the adjacent creek.

The level of the groundwater primarily varies with rainfall and climatic factors. Along the Hackensack River bank, shallow groundwater levels may also be affected locally by tides. Tidal influence is dependent on several factors including the tidal amplitude, the radian frequency of the tide, soil permeability, and soil porosity.

Field data collected on the Empire Tract in 1998 and 1999 showed groundwater levels to be at their highest during the early spring months (PS&S 2000a). These findings are consistent given that vegetation is dormant, and spring typically follows a period of regional winter storms and snowmelt that together contribute a large input of water to the wetlands. Also, groundwater levels gradually declined following the spring surge in plant growth, higher temperature, and evaporation, and lower precipitation. Groundwater levels declined throughout the summer months to their lowest levels, then began to rise again in the fall following the start of the dormant season.

Recent studies were completed at the site to determine the presence, distribution, and permeabilities of the banks and creek bottom linings of the three primary creeks on site, Muddabach Creek, Moonachie Creek, and Bashes Creek, where movement of water between the creeks and wetlands groundwater occur (PS&S 2001b). Along Moonachie Creek the lowest permeabilities were reported for the materials lining the creek bed. These materials consisted of fine-grained silt and clay sediment. The creek bank walls showed high permeabilities, as would be expected, because they consist predominantly of exposed peat with no sediment lining. This zone along the upper walls of the banks is where the greatest likelihood of exchange would occur, during periods of especially high creek or groundwater levels.

A comparison of Muddabach Creek and Moonachie Creek shows them to have very different bottom characteristics. At the sampled locations on Moonachie Creek, a distinct channel "lining" comprised of fine-grained silt, clay, and/or muck was observed. Muddabach Creek, however, appeared to have a thinner muck layer, with little if any distinct silt or clay lining at the sampled locations. This might be explained by the natural (Moonachie Creek) versus man-made (Muddabach Creek) creation of these creeks. The meanders displayed by Moonachie Creek suggests that it is an older, natural stream course (although possibly dredged) compared to Muddabach Creek. Moonachie Creek, therefore, has had more time for sediment accumulation to form a silt/clay lining. Much of Muddabach Creek is straight and channelized, and presumably excavated out of former meadowmat. Its recent history suggests it has had less time to infill with sediment. This condition might explain the relative absence of a distinct silt or clay layer on the creek bed, and the presence of fibrous peat beneath the muck layer that was found. These observations were confirmed by permeability testing of the bank soils and creek-lining sediment. The permeabilities of these materials were generally lower along Moonachie Creek than Muddabach Creek. As a result, it is anticipated that there would be more water exchange expected between the creek and wetlands groundwater along Muddabach Creek than Moonachie Creek. Bashes Creek was also inspected and was found to be similar to Moonachie Creek.

Recent site investigations and subsequent analysis suggest, however, that this interaction, or exchange, between the wetlands groundwater and the creeks is generally limited (PS&S 2001a). During the summer months, groundwater levels were sustained at levels significantly lower than the nearby creek levels, and showed little response to changes in creek levels. For the majority of the growing season, most of the vegetated wetlands on the Empire Tract do not appear to function as an open system with the creeks.

The driving force for groundwater movement is the hydraulic gradient. Water generally moves from areas of higher to lower water elevations. There is a direct relationship between the amount of exchange, and both the permeability and the hydraulic gradient. The greater the hydraulic gradient (i.e., the greater the difference between surface water and groundwater levels), the greater the potential for water movement. Similarly, the greater the permeability of the wetland soils or creek bed lining, the more readily the water can move, assuming a sufficient hydraulic gradient driving force exists.

Based on studies conducted on the Empire Tract, the greatest potential for interaction or exchange of water between the wetlands groundwater and the creeks appears to be when either groundwater or surface levels are at their highest (PS&S 2001b). For groundwater, this occurs in the late fall and winter. For surface water, this occurs during extreme storm events and high river tidal conditions. Sediment lining Moonachie Creek was shown to have a characteristically low permeability, which inhibits movement of water through the creek bottom under all conditions. Higher permeabilities were measured for the creek bed soils higher up on the creek walls and banks, where there is less of an accumulation of sediment. As would be expected, measured permeabilities of the creek banks and walls approached those measured for the meadowmat in the interior portions of the site. It is through the upper banks and creek walls where most exchange may occur, when either surface water or groundwater levels reach this level. These same higher permeabilities were also measured for soils lining the creek bottom and along the banks of Muddabach Creek. The data indicate that there is a greater potential for exchange between the wetlands and Muddabach Creek than along Moonachie Creek.

The exchange of water is dependent on the difference in water levels, or gradient, between the creeks and wetlands groundwater. During the growing season (spring and summer), when groundwater levels are at their lowest, surface waters may seep through the creek bottom (Muddabach) and banks (all creeks on site) into the wetlands when surface water levels are especially high. The greatest possible interaction is expected to occur during major storms at the end of the summer months. During these events, surface water levels are at their highest, and groundwater levels at their lowest, resulting in the maximum possible hydraulic gradient. However, the duration of high surface water levels may be short. During the dormant season (fall and winter) when groundwater levels are high compared to surface water levels, groundwater can seep into the creeks.

A simple mathematical model was developed for the site to determine the tidal influence on the groundwater hydrology (TAMS 1998). This model incorporated measured and field-tested soil properties such as soil permeability and porosity. The tidal influence on groundwater elevations generally decreases with distance from a tidal water body. For the Empire Tract, at distances of 50 ft or greater (15 m) from the Hackensack River bank, the model predicted no tidal influence on the groundwater.

Continuous field measurements of groundwater levels in monitoring wells installed on the Empire Tract were conducted over several monitoring periods to assess the tidal influence on the groundwater hydrology (well locations shown on Figure 6.3-1) (PS&S 2000a, PS&S 2001a). Surface water level measurements were also recorded at staff gauges at selected surface water locations. Monitoring results from September and November 1998 indicated, as expected, that the influence of tidal fluctuations from the Hackensack River decreases with increasing distance from the river, and that overall there is apparently little influence of tidal fluctuation in the river on groundwater levels on the site (PS&S 2000a; PS&S 2001a).

During a high tide period, and if tidal water levels are higher than groundwater levels, the elevated tidal waters will exert a temporary landward flow gradient, resulting in the seepage of tidal waters into the wetlands groundwater system. The landward extent of this flow with each tidal cycle is generally small, on the order of a few feet at most, due to the typical slow movement of groundwater and the relatively short period of time while the high tide level exists (a few hours). There is typically a time lag between the high tide event and associated rise in water levels in wells, consistent with the rate of movement of the pressure wave landward. The closer the well is to the tidal water body, the faster the response following the high tide event.

Boring logs and groundwater monitoring wells within the wetlands showed that the wetlands are saturated within one foot of the ground surface during the fall and winter (TAMS 1998, PS&S 2001a). The recent data was collected from a series of shallow groundwater that wells were installed within the wetlands adjacent to Moonachie Creek to determine the extent of any tidal influence of the creeks on groundwater (PS&S 2000a). As expected, the wells located closest to the Hackensack River showed the greatest potential influence of the river on groundwater elevations in the wetlands. For these two wells, cyclic fluctuations of up to a few inches were noted, which might be indicative of tidal effects. The other wells located more landward showed few if any fluctuations in water levels that might be attributed to tides. Conductivity data for these same wells also showed cyclic fluctuations, possibly indicative of tidal effects, but because the range in fluctuations appears to be so small, they are more likely due to the small movement of water with local conductivity variations or even instrument "noise." Regardless, tidal effects on the wetlands groundwater appear to be localized primarily along the Hackensack River.

Section 6.13 References

FEMA (Federal Emergency Management Agency). 1995. *Flood Insurance Study-Bergen County, New Jersey*. Volume 1 of 5.

NJDEP (New Jersey Department of Environmental Protection). 1988. *Technical Manual for Stream Encroachment*. Trenton, NJ n.p.

Paulus, Sokolowski and Sartor, Inc. (PS&S) 2000a. Surface Water Monitoring Program Summary Report for 1998 and 1999 Period for the Empire Tract. January 2000.

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TAMS. 1998. *Supplemental Additional Information Submission (SAIS).* Meadowlands Mills.

USEPA and USACE. (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers). 1995. *Draft Environmental Impact Statement for the Hackensack Meadowlands Special Area Management Plan*.

6.14 TRANSPORTATION (ROADWAY SYSTEM AND MASS TRANSIT)

The Empire Tract is located within the Hackensack Meadowlands Development (HMD) and is in close proximity to a network of existing roadways and highways. The New Jersey Turnpike's western spur is located to the east of the project site. Paterson Plank Road is located to the south, Washington Avenue is located to the west, and Commerce Boulevard and Empire Boulevard are located to the north of the project site. The Meadowlands Sports Complex and existing NJ Route 120 are located at the southwest corner of the project site (Figure 6.14-1).

6.14.1 Description of Roadway Network

The following is a brief description of the roadways in the vicinity of the Empire Tract:

- The Western Spur of the New Jersey Turnpike Western Spur is a major north/south interstate highway facility consisting of two to three lanes per direction. In the vicinity of the Empire Tract, Interchanges 16W and 18W provide connections to NJ Route 3 and the Sports Authority Complex roadway network. NJ Turnpike Interchange 18W currently exists as a partial interchange offering access only to the Sports Authority complex from the north, when events are occurring at the facility. In addition, the Interchange 18W toll facility is located on the mainline of the NJ Turnpike immediately to the south of this interchange. The New Jersey Turnpike's Western Spur has a posted speed limit of 55 mph and is under the jurisdiction of the New Jersey Turnpike Authority (NJTA).

- NJ Route 3 is a major limited-access, east/west state highway consisting of three to four lanes per direction. In the vicinity of the site, NJ Route 3 has major interchanges with NJ Route 17, NJ Route 120, and the New Jersey Turnpike's Western Spur. NJ Route 3 has a posted speed limit of 50 mph and is under the jurisdiction of the New Jersey Department of Transportation (NJDOT).

- NJ Route 17 is a north/south state highway. In the vicinity of the site, NJ Route 17 generally consists of three lanes per direction, with grade-separated interchanges provided at its crossings with Moonachie Avenue, Paterson Plank Road, and NJ Route 3. NJ Route 17 has a posted speed limit of 50 mph and is under the jurisdiction of the NJDOT.

- NJ Route 120 is a north/south limited-access state highway that consists of three lanes per direction between NJ Route 3 and Washington Avenue. NJ Route 120 has grade-separated interchanges with NJ Route 3, the Meadowlands Sports Complex, and Washington Avenue/Paterson Plank Road, where it continues to the west as Paterson Plank Road. NJ Route 120 south of Paterson Plank Road is under the jurisdiction of NJDOT and has a posted speed limit of 50 mph.

- Paterson Plank Road connects points from NJ Route 17 to the west and the Hackensack River to the east. The section of Paterson Plank Road between NJ Route 17 and Washington Avenue is also referred to as NJ Route 120 and is under the jurisdiction of NJDOT. Paterson Plank Road in this section is a divided, east/west arterial roadway consisting of two lanes per direction and has a posted speed limit of 40 mph. The section of Paterson Plank Road east of Washington Avenue is a local roadway consisting of one lane per direction. It has a posted speed limit of 25 mph and is under the jurisdiction of the Borough of Carlstadt.

- Washington Avenue (Bergen County Route 503) is a north/south undivided (in most areas) arterial roadway connecting the Township of Moonachie to the north with Paterson Plank Road and NJ Route 120 to the south. Washington Avenue consists of two lanes per direction and has a posted speed limit of 40 mph. Washington Avenue is under the jurisdiction of Bergen County.

- Moonachie Avenue is an east/west undivided arterial roadway connecting NJ Route 17 to the west with Washington Avenue to the east. Moonachie Avenue currently consists of one lane per direction with a center lane used for left turns. Moonachie Avenue is under the jurisdiction of Bergen County and has posted speed limits ranging from 30 to 40 mph.

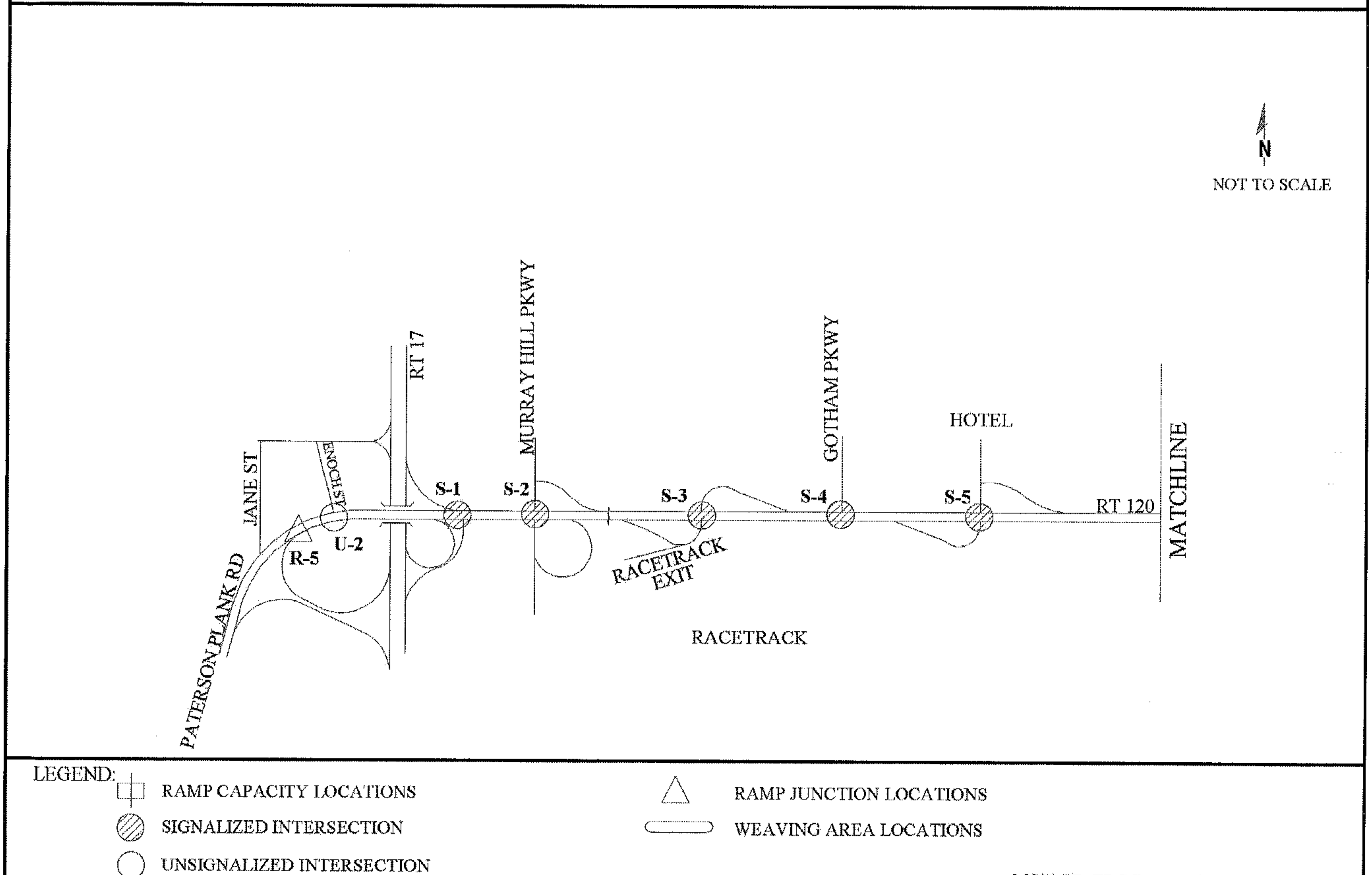
6.14.2 Field Studies

Available data regarding existing roadway conditions, right-of-way, and planned improvements on the highway and roadway network in the area surrounding the site were collected from the NJDOT, the NJTA, New Jersey Transit, Bergen County DPW, the NJMC, and local municipalities, and are available in the project record, held by USACE. Information regarding seasonal variations of traffic volumes was obtained from NJDOT and the NJTA both through discussions and review of data from their Automatic Traffic Recorder (ATR) counts. Description of data collected on existing traffic volumes is presented below. The analysis and interpretation of this data for the Existing Conditions is presented in Section 6.15.

Manual traffic counts were collected on Saturday, March 17, 2001 from 1:00 PM to 5:00 PM concurrent with three events occurring at the Meadowlands Sports Complex (a circus, an XFL football game and harness racing at the Racetrack). In addition, weekday counts were conducted on Wednesday, March 21, 2001 from 6:30 to 9:30 AM and 3:30 to 8:00 PM concurrent with two events occurring at the Meadowlands Sports Complex (a New Jersey Devils hockey game and harness racing at the Racetrack). The counts were conducted at the following locations (Figure 6.14.1):

- Intersection of Paterson Plank Road and Enoch Street

Existing 2001 Study Locations

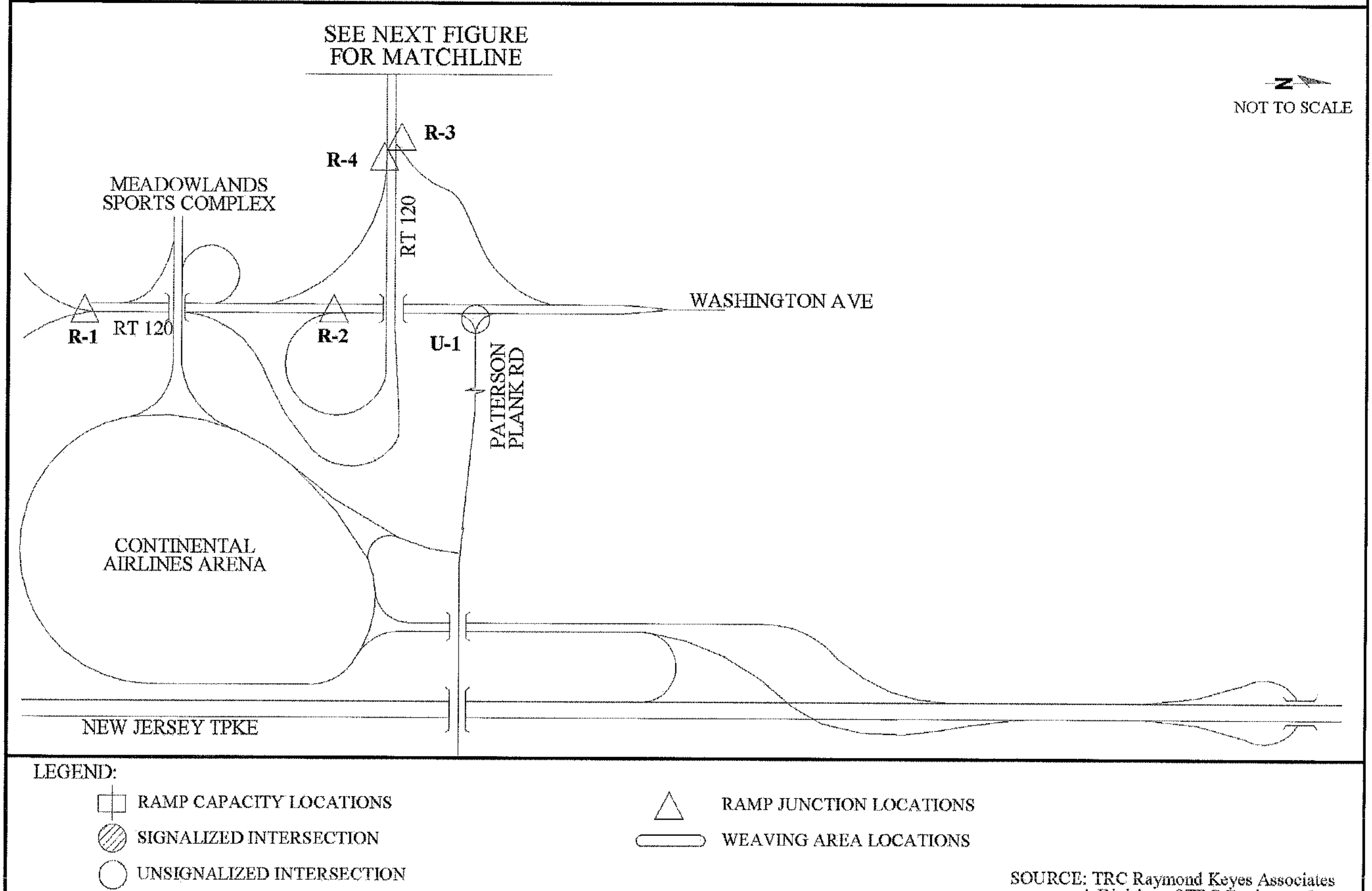


SOURCE: TRC Raymond Keyes Associates
A Division of TRC Engineers, Inc.

Figure 6.14-1

NOT TO SCALE

Existing 2001 Study Locations



SOURCE: TRC Raymond Keyes Associates
A Division of TRC Engineers, Inc.

Figure 6.14-1 (Continued)

NOT TO SCALE

- NJ Route 120/Paterson Plank Road & NJ Route 17 Interchange
- Route 120 & Murray Hill Parkway
- Route 120 & Jughandles/Racetrack Driveways
- Intersection of Paterson Plank Road and Gotham Parkway
- Route 120 & Jughandles/Hampton Inn Driveway
- Intersection of Washington Avenue and Paterson Plank Road
- Paterson Plank Road and Route 120 Westbound Ramp
- New Jersey Sports & Exposition Authority Turnpike Ramps
- Route 3 Westbound Merge with Route 120 Northbound

The manual turning movement counts were supported by ATR counts conducted for a one-week period from March 16 to March 23, 2001 at the following three ramp locations:

- Off-ramp from NJ Route 120 northbound to NJ Route 120/Paterson Plank Road Westbound.
- Off-ramp from Route 120 eastbound to Washington Avenue northbound.
- Off-ramp from Route 120 eastbound to Route 120 southbound.

The count data was checked against historical count data collected in 1991, 1996 and 1999 at times during which multiple events were held at the Meadowlands Sports Complex, as detailed in Table 6.14-1.

Table 6.14-1
Traffic Counts Conducted During Meadowlands Sports Complex Events

Date	Event
WEEKDAY	
Wednesday, June 18, 1996	Harness racing, carnival, and roller hockey
Thursday, June 19, 1996	Harness racing, a concert, and a carnival
Thursday, October 7, 1999	Harness racing, flea market, and ice hockey
SATURDAY	
Saturday, June 22, 1991	Harness racing, flea market, and a carnival
Saturday, June 29, 1991	Harness racing, concert, flea market, and a carnival
Source; TRC Raymond Keyes Associates. 2001	

When compared to historical count data in the study area, the 2001 counts showed volumes consistent with those collected in 1991, 1996 and 1999 during these periods.

Relevant traffic and physical inventory data were collected in the field for the roadways in the vicinity of the project site, including roadway geometrics, roadway channelization, roadside limitation, and traffic flow data (see sections 6.15 and 7.15).

6.14.3 Key Study Locations and Descriptions

Based on discussions with the NJMC and NJDOT, and a review of the potential development-generated traffic volumes, the following key locations were determined to require detailed traffic analyses. The locations are categorized as signalized intersections, unsignalized intersections, or ramp capacity locations. Field surveys of the existing roadway network indicated the following conditions at these key locations:

6.14.3.1 Signalized Intersection Locations

- Location S-1: Route 120/Paterson Plank Road and New Jersey Route 17 Northbound Ramps. Route 120 forms the major east/west legs of this signalized intersection. The NJ Route 17 northbound off-ramp forms the one-way northbound approach at this intersection and consists of one left-turn lane and one right-turn lane. Route 120 consists of two through lanes in each direction and has a posted speed limit of 40 mph at this location.

- Location S-2: Route 120/Paterson Plank Road and Murray Hill Parkway. Route 120 forms the east/west legs of this four-legged signalized intersection with Murray Hill Parkway. The eastbound Route 120 approach consists of two through lanes and a right-turn lane with left turns processed via a far-side loop ramp. The westbound Route 120 approach consists of two through lanes with left turns handled through a nearside jughandle. Murray Hill Parkway consists of two lanes northbound and one wide lane southbound.

- Location S-3: Route 120/Paterson Plank Road and Jughandles/Racetrack Driveways. Route 120 forms the east/west approaches of this signalized four-legged intersection. A U-turn jughandle forms the southbound approach while the Racetrack Driveway/U-turn jughandle forms the northbound approach. At this location, Route 120 consists of two through lanes in each direction. The northbound Racetrack Driveway approach consists of two lanes and the southbound approach consists of one wide lane.

- Location S-4: Route 120/Paterson Plank Road and Gotham Parkway. Route 120 forms the east/west approaches of this signalized T-intersection, consisting of two lanes per direction. Gotham Parkway forms the southbound approach and consists of one left-turn lane and one right-turn lane. Left turns are prohibited from eastbound Route 120 to Gotham Parkway.

- Location S-5: Route 120/Paterson Plank Road and Jughandle/Hampton Inn Driveway. The Hampton Inn Driveway forms the southbound approach and the jughandle from Route 120 eastbound forms the northbound approach to this signalized intersection with Route 120. Route 120 consists of two through lanes per direction, with left turns processed via nearside jughandles.

6.14.3.2 *Unsignalized Intersection Locations*

- Location U-1: Washington Avenue and Paterson Plank Road. Washington Avenue forms the north/south approaches to this unsignalized T-intersection with Paterson Plank Road and consists of two lanes per direction, separated by a median barrier. Paterson Plank Road forms the westbound approach, permitting only right-turn movements, under STOP sign control.

- Location U-2: Route 120/Paterson Plank Road and Enoch Street. Paterson Plank Road forms the major east/westbound approaches of this unsignalized intersection. Enoch Street forms the minor southbound approach of this T-intersection and operates under STOP sign control. Enoch Street serves local traffic as well as a significant amount of the New Jersey Route 17 southbound entering/exiting traffic.

6.14.3.3 *Ramp Capacity Locations*

- Location R-1: Route 3 Eastbound Merge with Route 120 Northbound. The ramp from Route 3 eastbound is a one-lane, left-hand ramp with an acceleration lane of approximately 250 feet. Route 120 northbound consists of three through lanes.

- Location R-2: Route 120 Eastbound Ramp and Washington Avenue Northbound. Washington Avenue northbound consists of two through lanes at this ramp junction. The ramp from Route 120 eastbound consists of one lane with a short acceleration lane.

- Location R-3: Route 120/Paterson Plank Road Westbound and Ramp from Washington Avenue Southbound. Route 120 westbound consists of two through lanes at this ramp junction. The ramp from Washington Avenue southbound is a one-lane, right-hand ramp.

- Location R-4: Route 120/Paterson Plank Road Eastbound and Ramp to Route 120 Southbound. Route 120 Eastbound consists of two lanes upstream of this diverge location with the ramp to Route 120 southbound. Beyond this location, Route 120 continues with one through lane. The ramp to Route 120 southbound consists of two lanes.

- Location R-5: Route 120/Paterson Plank Road Eastbound and Route 17 Southbound Ramp. Paterson Plank Road forms the eastbound approach to this merge location with the Route 17 southbound off-ramp. Paterson Plank Road consists of one through lane upstream and two through lanes downstream of this location, while the off-ramp consists of one lane.

6.14.4 Existing Public Transit

Currently, there are six public New Jersey Transit bus lines (Nos. 160, 161, 163, 164, 703, and 772) passing the Empire Tract that service the entire Meadowlands region, including both New Jersey and New York City commuting residents. Route 703 provides service between Haledon and East Rutherford, while the remaining routes provide local and express service between New Jersey communities and New York City. There is currently no train or rail service to or from the Empire Tract.

Section 6.14 References

Raymond Keyes Associates. 2001. *Traffic Impact Study (TIS)*. n.p.

6.15 TRAFFIC

Traffic conditions within the project study area were analyzed for the Existing Conditions based upon traffic data (spring 2001). A total of five signalized intersections, two unsignalized intersections, and five ramp junctions were analyzed (TRC Raymond Keyes Associates 2001).

6.15.1 Methodology

Detailed capacity analyses were conducted at the signalized and unsignalized intersections and ramp junctures in the study area (see Section 6.14) using the analytical procedures described in the *1997 Highway Capacity Manual (HCM); Special Report 209*, published by the Transportation Research Board. The Transportation Research Board is a unit of the National Research Council, a private, non-profit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

6.15.1.1 Signalized Intersections

The capacity of a signalized intersection is evaluated in terms of volume/capacity (V/C) ratio. The level of service (LOS) of a signalized intersection is typically determined for the peak 15-minute analysis period on the basis of control delay per vehicle (in seconds per vehicle). Control delay includes initial acceleration delay, queue move-up time, stopped delay, and final acceleration delay. Because of inherent complexities, a direct relationship between delay and capacity cannot be established. Both must be used to fully evaluate the operation of a signalized intersection. According to the HCM, control delays at LOS A, B, C, and D are generally considered acceptable for signalized intersections, with LOS E representing the limit of acceptable delay. Control delays associated with LOS F are unacceptable. The LOS criteria for signalized intersections, as defined in the 1997 HCM, are shown in Table 6.15-1:

Table 6.15-1
Signalized Intersection LOS Criteria

LOS	Control Delay Per Vehicle (Sec)
A	≤ 10
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	> 80.0
Source: Highway Capacity Manual, Special Report 209, 1997	

6.15.1.2 Unsignalized Intersections

The capacity of an unsignalized intersection is evaluated in terms of critical gap size and the LOS is evaluated on the basis of control delay per vehicle (in seconds per vehicle). Control delay includes initial acceleration delay, queue move-up time, stopped delay, and final acceleration delay, typically for the peak 15-minute analysis period. Average control delay of less than 10 seconds per vehicle is defined as LOS A, and an average control delay of 35 seconds per vehicle is the break point between LOS D and E. The average control delays for LOS A, B, C and D are considered acceptable for unsignalized intersections, while those associated with LOS E and F are considered unacceptable. LOS F for unsignalized intersections is the result of average control delays in excess of 50 seconds per vehicle. The LOS criteria for unsignalized intersections defined in the 1997 HCM are as follows in Table 6.15-2:

Table 6.15-2
Unsignalized Intersection LOS Criteria

LOS	Average Control Delay Per Vehicle (Sec)
A	≤ 10
B	>10 to 15
C	>15 to 25
D	>25 to 35
E	>35.1 to 50
F	> 50.0
Source: Highway Capacity Manual, Special Report 209, 1997	

6.15.1.3 Ramp Junctions

The capacity analysis of ramps was conducted using the methodologies contained in the updated 1994 Highway Capacity Manual, 3rd Edition, Section 5, "Ramps and Ramp Junctions". Ramp junction LOS is evaluated in terms of the density in the influence area of the ramp, a condition which depends on several factors such as the freeway volume upstream of ramp-freeway junctions, the volume of traffic entering or leaving at the ramps, the distance between points of entry and exit, and the geometric layout at the junction.

LOS for ramp freeway junctions and the ramp proper are defined in terms of density for passenger cars per mile per lane (pc/mi/ln). LOS A, B, C and D are considered acceptable, according to the HCM, for ramp junctions, while those associated with LOS E and F are considered unacceptable. Density is related to the traffic flow in the area of influence. The capacity analyses that define the 2001 peak hour conditions are summarized in Table 6.15-3.

Table 6.15-3
Ramp Junction LOS Criteria

Level of Service	Ramp-Freeway Junction Maximum Density pc/mi/ln	Ramp Proper Density Range pc/mi/ln
A	10	0 – 10.0
B	20	10.1 – 16.0
C	28	16.1 – 24.0
D	35	24.1 – 32.0
E	>35	32.1 – 45.0
F	Demand flow exceeds limits of HCM Table 5-1	>45.0

Source: Highway Capacity Manual, Special Report 209, 1997

6.15.2 Existing 2001 Peak Hour Determination

In order to conservatively analyze the potential impacts of the various project alternatives on the local roadway network, the peak hour time periods during which traffic volumes generated by the proposed project would be most substantial were identified. The traffic volumes during these peak hours were utilized as the basis for assessing the potential impact of the various alternatives on study area traffic conditions. The following is a discussion of the considerations underlying the selection of the peak hour time periods.

The Bergen County "Blue Law" prohibits shopping on Sunday within the County. Such "Blue Laws" can lead to higher retail sales on Saturday at establishments attracting patrons from within the county. However, the proposed project would draw traffic from more than a 40-mile radius where shopping opportunities are available in the neighboring municipalities that do permit shopping on Sundays. As a result, it is anticipated that traffic generated by the proposed project on a Saturday would be not be significantly different if this facility was permitted to operate on Sundays.

The majority of traffic generated by the development will generally occur outside periods of greatest traffic activity at the Meadowlands Sports Complex; i.e., football games on Sundays, assuming the "Blue Law" is not repealed. Peak Hour conditions on a Sunday relative to major occurrences at the Meadowlands Sports Complex are not considered representative of design conditions and are typically handled by the Traffic Management Plan implemented along the New Jersey Turnpike between Exits 16W and 18W at the time of major events.

Traffic from the development would be less on Sunday than Saturdays or weekdays because major components of the development (office and retail) would be closed. In general, Sunday traffic in the region on days when a football game is not scheduled at the Meadowlands sports complex is lower than traffic generated on a Saturday. This is supported by data obtained from a permanent count location on the New Jersey Turnpike in the vicinity of the project. Table 6.15-4 summarizes the average daily traffic for Saturdays and Sundays by month in 1998.

Table 6.15-4
1998 Average Daily Traffic Volumes by Month
New Jersey Turnpike

Month	Saturday	Sunday
January	66,050	59,810
February	68,210	64,970
March	69,510	67,680
April	80,400	75,660
May	78,760	75,670
June	84,420	82,310
July	86,570	81,610
August	88,580	82,970
September	81,410	76,090
October	77,840	73,960
November	74,410	67,910
December	39,640	36.480
AVERAGE	74,650	70,427
Source: New Jersey Department of Transportation, 1998 Continuous Count Station		

Based on the provisions of the New Jersey State Highway Access Management Code (NJAC 16:47-4.30), the Peak AM Highway Hour is not a required study hour since the projected Peak AM Hour generations of the development are anticipated to be 50 percent or less of the projected Peak PM Highway Hour generations (the maximum Peak Hour generations projected for the project). However, to ensure adequate operating conditions during this time period on the roadway network, including proposed modifications to the New Jersey Turnpike Ramp System, the Peak AM Hour will be evaluated at the following critical control locations:

Signalized Intersections
S-1. Route 120 and Route 17 Northbound Ramps
S-2. Route 120 and Murray Hill Parkway
S-4. Route 120 and Gotham Parkway
S-5. Route 120 and Jughandle/Hampton Inn Driveway

Ramp Junctions
R-1. Route 3 Westbound Merge with Route 120 Northbound
It has been established that the proposed project would generate the highest level of traffic during

the Weekday Peak PM Period (4:00 to 7:00) and Peak Saturday Hours (12:00 to 4:00) As a result, specific hours within these periods will be analyzed for the critical locations in the study area (These hours are detailed below). In addition, it has been determined by the New Jersey Turnpike Authority and New Jersey Meadowlands Commission that the Peak PM Event Hour (7:00 to 8:00 PM on a weekday, based on the 2001 counts) is also a critical study hour due to the close proximity of the proposed project to the Meadowlands Sports and Exposition Authority Complex. For the Weekday Peak PM, Weekday Peak PM Event Hour, and Peak Saturday Hours, the following critical locations will be analyzed:

Signalized Intersections

S-1. Route 120 and Route 17 Northbound Ramps
S-2. Route 120 and Murray Hill Parkway
S-3. Route 120 and Jughandles/Racetrack Driveways
S-4. Route 120 and Gotham Parkway
S-5. Route 120 and Jughandle/Hampton Inn Driveway

Unsignalized Intersections

U-1. Washington Avenue and Paterson Plank Road
U-2. Route 120 and Enoch Street

Ramp Junctions

R-1. Route 3 Eastbound Merge with Route 120 Northbound
R-2. Route 120 Eastbound Ramp and Washington Avenue Northbound
R-3. Route 120/Paterson Plank Road Westbound and Washington Avenue Connector
R-4. Route 120/Paterson Plank Road Eastbound and Ramp to Route 120 Southbound
R-5. Route 120 and Route 17 Southbound Ramps

Traffic counts were performed on days when events were occurring at the Sports Complex during these periods (with the exception of Weekday AM). Based upon the traffic data collected and the preceding discussion regarding the various peak periods considered, the individual traffic peak hours were determined to be as follows:

- Weekday Peak AM Highway Hour 7:30 to 8:30 AM
- Weekday Peak PM Highway Hour 4:45 to 5:45 PM
- Weekday Peak PM Event Hour 7:00 to 8:00 PM
- Saturday Peak Highway Hour 2:15 to 3:15 PM

The 2001 Existing Traffic Volumes are shown on Figures 6.15-1 through 6.15-4 for the Weekday Peak AM highway hour, Weekday Peak PM highway hour, Weekday Peak PM event hour, and the Saturday Peak highway hour, respectively.

6.15.3 Existing 2001 Analysis Summary

Based upon the analysis and results included in Table 6.15-5, a study concluded that the area roadway network under current conditions generally operates at acceptable LOS, except for the signalized intersection of Rt. 120/Paterson Plank Road and Murray Hill Parkway (LOS "E") during the Weekday Peak PM hour.

Table No. 6.15-5
Level Of Service Summary
Signalized Intersection Locations
2001 Existing Conditions

Location		Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday PM Event Peak Hour	Saturday Peak Hour
S-1.	Rt. 120/Paterson Plank Rd. & Rt. 17 NB Ramps	B 10.3 secs.	C 27.4 secs	A 7.9 secs.	A 7.4 secs.
S-2.	Rt. 120/Paterson Plank Rd. & Murray Hill Pkwy.	C 29.3 secs.	E 76.9 secs	B 18.0 secs.	B 13.7 secs.
S-3.	Rt. 120/Paterson Plank Rd. & Jughndle/Racetrack	N/A.	C 27.7 secs	A 8.6 secs.	A 8.7 secs.
S-4.	Rt. 120/Paterson Plank Rd. & Gotham Pkwy.	B 13.9 secs.	B 18.9 secs	B 12.4 secs.	A 4.6 secs.
S-5.	Rt. 120/Paterson Plank Rd & Jughndle/Hampton	D 36.0 secs.	B 10.1 secs	A 9.3 secs.	A 7.4 secs.

TRC Raymond Keyes Associates. 2001
N/A Peak hour not analyzed at this location

The unsignalized intersection analysis results are summarized in Table 6.15-6. The Washington Avenue and Paterson Plank Road intersection operates at an acceptable LOS during all periods analyzed. The unsignalized intersection of Paterson Plank Road and Enoch Street operates at LOS "F" during all periods as a result of the minor street left-turn movements from Enoch Street.

Table No. 6.15-6
Level of Service Summary
Unsignalized Intersection Locations
2001 Existing Conditions

Location		Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday PM Event Peak Hour	Saturday Peak Hour
U-1.	Washington Ave. & Paterson Plank Rd.	C 17.3 secs	B 12.8 secs.	B 10.4 secs.	B 10.1 secs.
U-2.	Paterson Plank Rd. & Enoch Street	NA	F 304.3 secs.	F 111.8 secs.	F 94.1 secs.

TRC Raymond Keyes Associates. 2001
N/A Peak hour not analyzed at this location

As depicted in Table 6.15-7, all ramp junction locations operate at an acceptable LOS during each of the peak periods analyzed.

Table 6.15-7
Level Of Service Summary
Ramp Junction Locations
2001 Existing Conditions

Location		Weekday AM Peak Hour	Weekday PM Peak Hour	Weekday PM Event Peak Hour	Saturday Peak Hour
R-1.	Rt. 3 EB Merge & Rt. 120 NB	C 24 pc/mi/ln	C 22 pc/mi/ln	C 25 pc/mi/ln	B 20 pc/mi/ln
R-2.	Rt. 120 EB Ramp & Washington Av NB	N/A	B 14 pc/mi/ln	A 10 pc/mi/ln	A 9 pc/mi/ln
R-3.	Rt. 120 WB & Washington Avenue Connector Rd.	N/A	B 15 pc/mi/ln	A 9 pc/mi/ln	A 9 pc/mi/ln
R-4.	Rt. 120 EB & Ramp to Rt. 120 SB	N/A	A 8 pc/mi/ln	B 10 pc/mi/ln	A 6 pc/mi/ln
R-5	Paterson Plank Rd. & Rt 17 SB Off Ramp	N/A	B 14 pc/mi/ln	B 18 pc/mi/ln	B 15 pc/mi/ln

TRC Raymond Keyes Associates. 2001
N/A Peak hour not analyzed at this location

Section 6.15 References

New Jersey Department of Transportation, 1998. Continuous Count Station.

TRC Raymond Keyes Associates. 2001. *Traffic Impact Study (TIS)*. n.p.

6.16 AIR QUALITY

6.16.1 National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (USEPA), under the requirements of the Clean Air Act (CAA), as amended, has established National Ambient Air Quality Standards (NAAQS) for six contaminants referred to as criteria pollutants (40 CFR 50). These are carbon monoxide, nitrogen dioxide, ozone, particulate matter, lead, and sulfur dioxide. These contaminants result from mobile sources (traffic) and stationary sources (factories, operating equipment, etc.), and are described below.

- Carbon monoxide (CO) is a colorless odorless gas. Carbon monoxide is the most commonly occurring air pollutant. The major sources of CO are the incomplete combustion of fuels used to power vehicles, heat buildings, process raw materials, and incinerate refuse. CO-contaminated air has associated health effects, including reduced transport of oxygen by the bloodstream as a consequence of CO displacing oxygen in hemoglobin. Exposure to very high levels of CO can be lethal, and short duration exposure to high levels can cause headaches, drowsiness, or loss of equilibrium.

- Nitrogen dioxide (NO_2) is a yellowish-brown gas that is present in urban environments. Nitrogen dioxide is primarily formed in the atmosphere by the oxidation of nitric oxide (NO_x). A major source of nitric oxide and nitrogen dioxide emissions is fuel combustion in boilers associated with electric utilities and industrial facilities. Other sources include motor vehicles. Nitrogen oxides cause irritation to the lungs, bronchitis, pneumonia and lowered resistance to respiratory infections.

- Ozone (O_3) is a photochemical oxidant and a major constituent of smog. Hydrocarbons and nitrogen oxides react in the presence of sunlight to form ozone. This reaction usually occurs gradually downwind from the site where the contaminants are emitted, causing impacts in areas well beyond the emission source. High concentrations of ozone are a major health and environmental concern, particularly for individuals with existing lung function impairment. Ozone is a principal cause of lung and eye irritation in urban environments.

- Particulate matter in an urban environment occurs as a result of incomplete fuel combustion in stationary equipment and motor vehicles as well as various manufacturing operations. An inhalable particulate is defined as a particulate that is less than 10 microns (PM10) in diameter. The inhalation of particulates can impair pulmonary function, and smaller particles tend to penetrate deeper into the lung.

- Lead (Pb) is a bluish-gray metal usually found in small quantities in the earth's crust. The most significant contributors of emissions of lead particulates to the atmosphere are gasoline additives, iron and steel production, and alkyl lead manufacturing. Other sources of lead emissions include the combustion of solid waste, windblown dust from the weathering of lead-based paint, and cigarette smoke. The use of lead-free gasoline in vehicles has considerably reduced airborne lead levels in the urban environment. Exposure to lead is dangerous for fetuses and can result in premature birth. Other health effects include decreased intelligence quotient (IQ) for infants and small children, increased blood pressure in middle-aged men, and brain and kidney damage in adults and children.

- Sulfur dioxide (SO_2) is emitted into the atmosphere primarily from the combustion of sulfur-bearing fuels for space heating, industrial production and motor vehicles. The use of low sulfur fuels for space heating and industrial production has reduced the amount of sulfur dioxide emitted from those sources. The combustion of gasoline and diesel fuels in motor vehicles accounts for a very small percentage of the total sulfur dioxide emitted. Respiratory illness and damage to the respiratory tract are both health effects associated with the inhalation of sulfur dioxide emissions.

The NAAQS include primary and secondary standards. The primary standards were established at levels to protect public health with an adequate margin of safety. The secondary standards were established to protect the public welfare from the adverse effects associated with pollutants in the ambient air without an adequate margin of safety. These standards are presented in Table 6.16-1.

The CAA requires that USEPA review scientific data every five years to ensure that the NAAQS effectively protect the public health. The USEPA changed the primary and secondary ozone NAAQS effective on September 16, 1997, from 0.12 parts per million (ppm) of ozone measured over 1 hour to a standard of 0.08 ppm measured over 8 hours, with the average fourth-highest concentration over a 3-year period determining whether an area is in compliance. Following the promulgation of these revised NAAQS, the CAA provides up to 3 years for USEPA to designate areas according to most recent air quality data. States will have up to three years from designation to develop and submit State Implementation Plans (SIPs) to provide for attainment of the new standard. While the NJ State is pending for USEPA's designation for 8-hour ozone status, a revision of SIP for 1-hour Ozone was proposed in October 2001.

A new standard for particulate matter was issued on July 18, 1997 by USEPA. The standard for PM10 remains unchanged, while a new standard for fine particles (PM2.5, with a diameter of 2.5 micrometers or less) is set at an annual limit of 15 micrograms per cubic meter ($\mu g/m^3$), with a 24-hour limit of 65 $\mu g/m^3$. As this new standard will regulate fine particulates for the first time, USEPA is allowing five years for the development of a nationwide monitoring network and for the collection and analysis of data needed to designate areas and develop implementation plans. Since the study area is currently in attainment for particulate matter (PM), no SIP is required.

Table 6.16-1
National and New Jersey Ambient Air Quality Standards.

Pollutant	Standard	Averaging Period	New Jersey (a)		National (b)	
			(µg/m³)	(ppm)	(µg/m³)	(ppm)
Sulfur Dioxide	Primary	24-hour average (c)	365	0.14	365	0.14
		12-month arith. mean	80	0.03	80	0.03
	Secondary	3-hour arith. mean (c)	1300	0.5	1300	0.50
		24-hour arith. mean	260	0.10		
		12-month arith. mean	60	0.02		
Total Suspended Particulates	Primary	24-hour arith. mean	260	-----	-----(d)	-----
		12-month geom. mean	75	-----	-----	-----
	Secondary	24-hour arith. mean	150	-----	-----(d)	-----
		12-month geom. mean (e)	60	-----	-----	-----
Inhalable Particulates (PM10)	Primary and Secondary	24-hour arith. mean	-----	-----	150	-----
		Annual arith. mean	-----	-----	50	-----
Fine Particulates (PM2.5)	Primary and Secondary	24-hour arith. mena	-----	-----	65	-----
		Annual arith. mean	-----	-----	15	-----
Carbon Monoxide	Prim. & Sec. (f)	1-hour arith. mean	40,000	35	40,000	35
		8-hour arith. mean	10,000	9	10,000	9
Ozone	Primary	Max. Daily 1 Hr. arith. mena	235	0.12	235	0.12 (g)
	Secondary	1-hour arith. mean	160	0.08	235	0.12
	Primary and Secondary	8-hour arith. mean	-----	-----	157	0.08
Nitrogen Dioxide	Prim. & Sec.	12-month arith. mean	100	0.05	100	0.053
Lead	Prim. & Sec.	3-month arith. mean	1.5	-----	-----	-----
		quarterly mean	-----	-----	1.5	-----

Notes:
(a) New Jersey short-term standards are not to be exceeded more than once in any 12-month period.
(b) National short-term standards are not to be exceeded more than once in a calendar year.
(c) National standards are block averages rather than moving averages.
Source: 40 CFR Part 50 and NJAC 7:27-13
(d) As of 1991, this pollutant classification changed to PM-10, which emphasizes the smaller particles.
(e) Intended as a guideline for achieving short-term standard.
(f) National secondary standards for carbon monoxide have been rescinded.
(g) Maximum daily 1-hour average: averaged over a three year period. The expected number of days above the standards must be less than or equal to one.
arith. mean = arithmetic mean; geom. mean = geometric mean

6.16.2 Background Air Quality

The existing background ambient air quality of the study area can be characterized based on monitoring data collected by the NJDEP. Criteria pollutant concentration data is collected at several monitoring locations throughout the State of New Jersey. This data is compiled analyzed, and summarized annually.

The maximum levels monitored during 1996, 1997 and 1998 at the NJDEP monitoring locations closest to the project site are presented in Table 6.16-2 and can be considered representative for conditions in the general area. The ambient air levels measured were well below the corresponding ambient air quality standards, except for ozone, which was below but close to the standard. This ozone level is expected since the region where the Empire Tract and the ozone monitoring site are located has been designated as a non-attainment area for ozone.

Currently, air quality in the area of the Empire Tract has been designated as attaining the NAAQS for NO_2, SO_2 and PM10, but is designated by USEPA as nonattainment for carbon monoxide and ozone.

Carbon Monoxide

Bergen County, Essex County, Hudson County, Union County and a portion of Passaic County in New Jersey have been designated by the USEPA as a nonattainment area with respect to the carbon monoxide NAAQS. The designation was made for Metropolitan Statistical Area (MSA) boundaries for the New York - Northern New Jersey - Long Island MSA, based on the highest monitored carbon monoxide concentrations in the MSA. Carbon monoxide monitoring data for 1992 through 1999 collected by the NJDEP Bureau of Air Monitoring for the City of Hackensack and the Borough of Fort Lee indicate that the carbon monoxide Ambient Air Quality Standards have not been exceeded. NJDEP ambient air monitoring data for North Bergen (Hudson County) indicate that the Carbon Monoxide Ambient Air Quality Standards have not been exceeded since 1994. The NJDEP has been implementing various control measures to address the carbon monoxide nonattainment in these Northeastern New Jersey Counties. Bergen County has not been redesignated at this time, and is still labeled as part of the MSA nonattainment area.

NJDEP monitoring data from Bergen County has shown that the carbon monoxide ambient air quality standard is not being exceeded at local NJDEP monitoring stations (Table 6.16-2). In response to this, the USEPA has indicated in the Federal Register (Vol. 64, No. 224, 11/22/99) that the northern New Jersey region has demonstrated attainment with respect to the carbon monoxide Ambient Air Quality Standard.

Further analysis of the carbon monoxide levels at local intersections is presented in Section 6.16-4.

Table 6.16-2
Background Ambient Air Data

Pollutant	Averaging Period	Maximum			2nd High			Monitoring Location
		1998	1999	2000	1998	1999	2000	
TSP (µg/m³)	24-hr	401	---	---	106	---	---	12th St., New Brunswick, Middlesex County
	12-month geom. mean	48.2	---	---	---	---	---	
PM10 (µg/m³)	24-hr	79	63	83	77	56	65	3401 Tonnele Ave., North Bergen, Hudson County
	Annual Mean	36.2	35.2	---	---	---	---	
Lead (µg/m³)	Quarterly Mean	0.080	0.180	0.150	---	---	---	12th St., New Brunswick, Middlesex County
SO_2 (ppm)	3-hr	0.060	0.043	---	0.059	0.042	---	St. Charles & Berlin St., Newark, Essex County
	24-hr	0.031	0.027	---	0.027	0.022	---	
	Annual Mean	0.008	0.006	---	---	---	---	
NO_2 (ppm)	Annual Mean	0.033	0.033	---	---	---	---	St. Charles & Berlin St., Newark, Essex County
O_3 (ppm)	1-hr	0.129	0.133	---	0.112	0.122	---	St. Charles & Berlin St., Newark, Essex County
CO (ppm)	1-hr	11.5	10.5	9.1	10.3	10.0	8.5	3401 Tonnele Ave., North Bergen, Hudson County
	8-hr	6.0	6.4	5.5	5.6	6.1	4.8	

Note: Monitoring data does not include data for comparison with new ozone and PM2.5 standards.
Source: *1996 Air Quality Report*, NJDEP Bureau of Air Monitoring, August 1997.
1998 Air Quality Report, NJDEP Bureau of Air Monitoring, September 1999.
1999 Air Quality Report, NJDEP Bureau of Air Monitoring, December 2000.
2000 Air Quality Report, NJDEP Bureau of Air Monitoring, January 2002.

Ozone - The State of New Jersey has been designated by USEPA as a nonattainment area with respect to the ozone NAAQS. The control of ozone has focused on reducing emissions of hydrocarbons and nitrogen oxides both regionally and throughout the State from various emission sources such as solvent and petrochemical sources, stationary combustion sources, and mobile sources.

6.16.3 Mobile Source Carbon Monoxide

CO is a site-specific pollutant which accumulates at a local level and can cause local air quality impacts, and usually will not affect the ambient air quality in the areas distanced from the sources To determine existing conditions and assess potential impacts on air quality, microscale "hot-spot" mobile source studies for carbon monoxide were conducted to determine existing conditions at certain intersections for traffic plans proposed for Empire Tract Alternative D and Empire Tract Alternative E (PS&S 2000, PS&S 2001). The CO microscale air quality analyses were conducted in accordance with requirements and procedures indicated in the Federal Transportation Conformity Rule (40 CFR Parts 51 and 93) Section 93.123, as well as with guidelines and assumptions outlined in the NJDEP document 'Air Quality Analysis for Intersections' (AQAI) (NJDEP, November 1996). These guidelines have been approved by USEPA and the FHWA.

As set forth below, mobile source air quality dispersion modeling was performed for CO emissions released from traffic at selected intersections in the vicinity of the project site. The modeling analyses were performed using USEPA and NJDEP approved models and modeling guidelines. Peak hour traffic conditions were simulated to assess the potential worst-case existing and future air quality conditions and impacts, including those conditions directly attributable to future no-build traffic, and project-related traffic. These air quality concentrations were analyzed to be compared with the NAAQS and New Jersey Ambient Air Quality Standards that have been established at levels to protect public health and welfare with an adequate margin of safety. All existing and predicted future CO concentrations were less than the applicable Ambient Air Quality Standards.

6.16.3.1 Existing 1999 and 2001 Carbon Monoxide Concentrations

Mobile source air quality studies were conducted based on traffic analyses (PS&S 2000, PS&S 2001). The 2000 study provided existing conditions for one intersection, Moonachie Avenue and Route 17, while the 2001 study provided existing conditions for another intersection, Route 120 and Racetrack Driveway/Jughandles. Effects on carbon monoxide concentrations resulting from existing traffic were determined in two steps: 1) vehicle exhaust emission factors were calculated using the USEPA Mobile5a_h computer model; and 2) these emission factors were used as input for the USEPA CAL3QHC pollutant dispersion model. This computer model then calculated CO concentrations at different distances from the source. The models used are described as follows:

- Mobile5a_h generates vehicular emission factors based on locality-specific vehicle fleet characteristics including vehicle age, operating mode of vehicles (hot/cold starts), and percentage of oxygenated fuel used. Additionally, Mobile5a_h can incorporate adopted emission control strategies such as anti-tampering programs and inspection and maintenance (I/M) programs including stringency, compliance rate, waiver rate, and vehicle years covered.

- CAL3QHC (Version 2) predicts the level of CO or other pollutant concentrations from motor vehicles traveling near roadway intersections. The model incorporates inputs such as roadway geometry, traffic volumes, vehicular emission rates, and meteorological conditions.

CO Assessment

Worst-case existing CO conditions were estimated for receptor locations at four intersections (Figure 6.16-1). The modeling was based on NJDEP Mobile Source Modeling Criteria. The four signalized intersections were selected for modeling based upon the 1999 and 2001 traffic analyses associated with the project. Based on traffic analysis performed for signalized intersections in the neighborhood, two of these intersections could experience the maximum changes in future traffic patterns as a result of a project, or as part of the future no-build condition. The PM peak period was modeled, because it was determined that this time period would represent the worst-case operating conditions (see Section 6.15). Receptors were placed at locations along roadway edges. The carbon monoxide concentration estimates for each receptor and each wind direction modeled were reviewed and the highest predicted result was selected as the worst-case carbon monoxide concentration.

Two of the intersections studied are existing intersections (Intersection of Moonachie Avenue and Route 17; and Intersection of Route 120 and Racetrack Driveway/Jughandles). The remaining two intersections do not currently exist and thus have only been modeled in order to provide a baseline against which future build conditions can be evaluated.

Locality-specific composite emission factors provided by NJDEP were used in the model. These composite emission factors were generated using the Mobile5a-h model. Idle emission factors were determined from the Mobile5a-h output in accordance with USEPA guidance (USEPA 1993).

The microscale CO analysis was performed using CAL3QHC (Version 2). The model incorporated the composite emission factors, current traffic volumes and intersection phasing data, and worst-case meteorological conditions in order to determine the maximum air quality impact of the existing roadway conditions.

Background Concentration

Total ambient CO concentrations near intersections consist of two components: local source contributions (i.e., vehicular emissions near intersections) and background contribution from other sources, such as stationary sources, in the study area. No recorded background CO data is available for the Empire Tract alone and CO data provided in Table 6.16-2 includes concentrations from both local sources and other sources.

The NJDEP default values for urban areas given in the NJDEP AQAI guidance document

(NJDEP 1996) were used as ambient background carbon monoxide concentrations. The background carbon monoxide concentration values used were 5.0 ppm for the 1-hour and 3.5 ppm for the 8-hour averaging periods, respectively, for the 2000 and 2001 analyses.

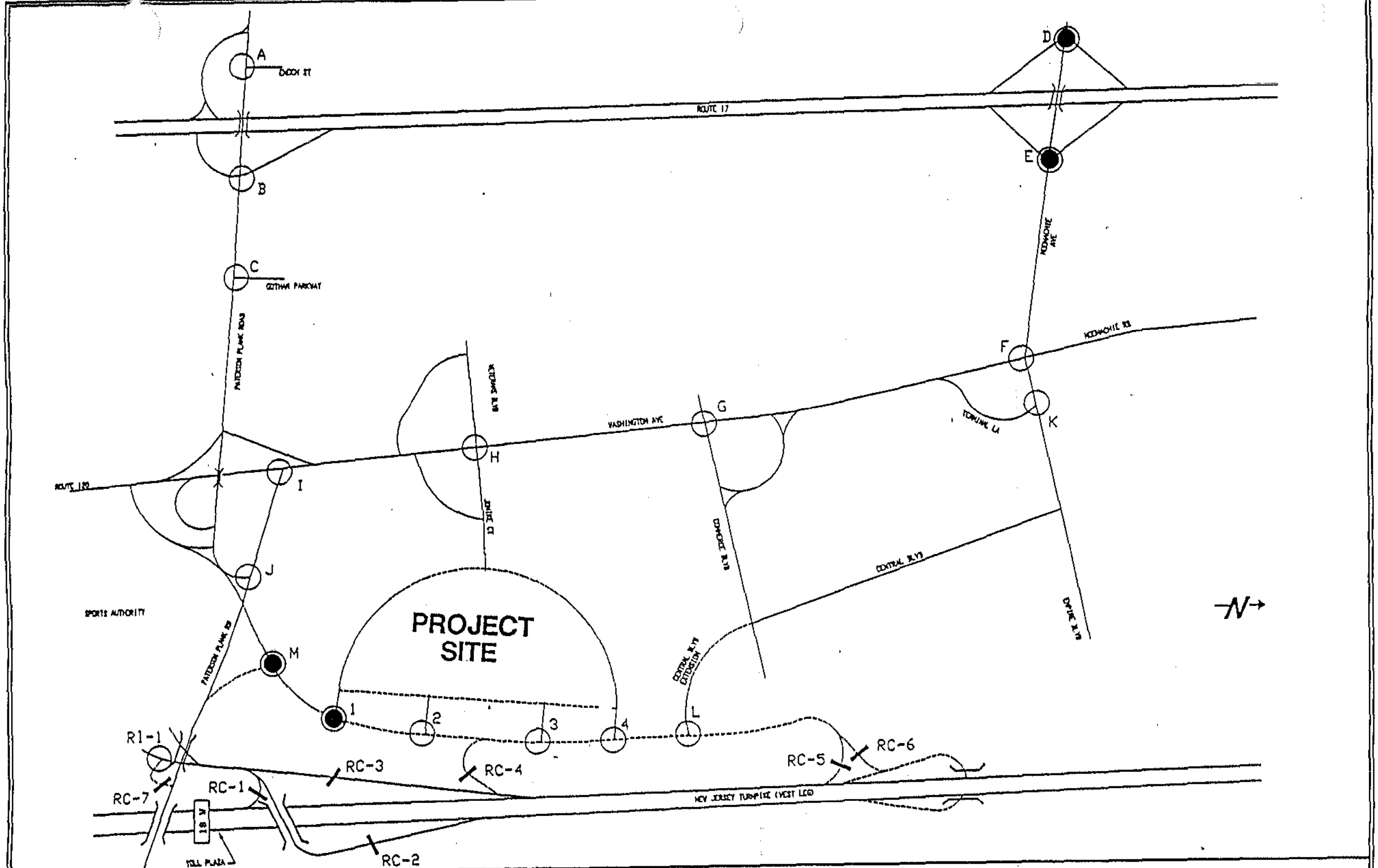
Persistence Factor

The 8-hour CO concentrations were estimated by multiplying the modeled 1-hour concentrations by an atmospheric persistence factor. The atmospheric persistence factor of 0.70 is utilized by NJDEP (NJDEP 1996) as a mechanism to estimate 8-hour concentrations from 1- hour modeled concentrations taking into account meteorological variability and changes in traffic volume.

Results

The modeled existing CO concentrations for the intersection of Moonachie Avenue and Route 17, and the intersection of Route 120 and Racetrack Driveway/Jughandles are presented in Table 6.16-3 and Table 6.16-4, respectively. The analysis modeled 1-hour and 8-hour carbon monoxide concentrations of 10.1 ppm and 7.1 ppm based on the 1999 traffic analysis (PS&S 2000). The existing conditions based on the 2001 traffic analysis modeled 1-hour and 8-hour concentrations of 7.4 ppm and 5.2 ppm. None of the modeled concentrations exceed the 35 ppm and 9 ppm National and New Jersey AAQS for CO, for the 1-hour and 8-hour averaging periods, respectively. More specific details of the methods and results of the carbon monoxide modeling study are provided in the Mobile Source Air Quality Impact Assessments for the Project (PS&S 2000, PS&S 2001).

The CO modeling evaluates emissions from traffic at actual and notional intersections in the vicinity of the proposed project site. All modeling analyses were performed using USEPA and NJDEP approved models and the procedures used were in accordance with USEPA and NJDEP modeling guidance. The modeling analyses were performed for peak hour traffic for existing conditions, and future no-build conditions, for the existing intersections and future build conditions for all intersections, to assess the potential for air quality condition changes or impacts associated with the project. The analyses focus on the peak hour traffic volumes, since it is at these times that maximum traffic, maximum delay, and maximum idling would be expected to occur usually resulting in the highest expected CO concentration impacts. The models used as well as the prescribed procedures tend to be conservative (i.e., tend to predict higher concentrations). No violations of the AAQS for CO are predicted under the predicted existing worst-case traffic conditions; no CO violations would be expected under existing normal traffic conditions.



TRC Raymond Keyes Associates

JOB: 21053
DATE: 11/15/99
FIGURE: 2.9.1

KEY LOCATIONS
INTERSECTIONS & RAMPS

LEGEND:
● AIR QUALITY MODELING LOCATIONS

AIR QUALITY MODELING LOCATIONS

BERGEN COUNTY, NEW JERSEY

Scale: NOT TO SCALE

Date: November 1999

Figure 6.16-1

Table 6.16-3
Predicted 1999 Existing Carbon Monoxide Concentrations at Moonachie Avenue and Route 17 Ramps

	Carbon Monoxide Concentration (ppm)
1-Hour Averaging Period	
Maximum Modeled 1-Hour CO Concentration	5.1
+ Background 1-Hour CO Concentration	5.0
= Predicted Maximum 1-Hour CO Concentration	10.1
8-Hour Averaging Period	
Maximum Predicted 1-Hour CO Concentration	5.1
× Atmospheric Persistence Factor (b)	0.7
= Maximum Modeled 8-Hour CO Concentration	3.6
+ Background 8-Hour CO Concentration	3.5
= Predicted Maximum 8-Hour CO Concentration	7.1

Notes:
National and New Jersey Ambient Air Quality Standards for CO (AAQS):
1-Hour Average = 35 ppm
8-Hour Average = 9 ppm
Source: PS&S 2000

Table 6.16-4
Predicted 2001 Existing Carbon Monoxide Concentrations at Route 120 and Racetrack Driveway / Jughandles

	Carbon Monoxide Concentration (ppm)
1-Hour Averaging Period	
Maximum Modeled 1-Hour CO Concentration	2.4
+ Background 1-Hour CO Concentration	5.0
= Predicted Maximum 1-Hour CO Concentration	7.4
8-Hour Averaging Period	
Maximum Predicted 1-Hour CO Concentration	2.4
× Atmospheric Persistence Factor (b)	0.7
= Maximum Modeled 8- Hour CO Concentration	1.7
+ Background 8-Hour CO Concentration	3.5
= Predicted Maximum 8-Hour CO Concentration	5.2

Notes:
National and New Jersey Ambient Air Quality Standards for CO (AAQS):
1-Hour Average = 35 ppm
8-Hour Average = 9 ppm
Source: PS&S 2001

6.16.4 Clean Air Act Conformity

The Clean Air Act Amendments (CAAA) of 1990 expands the scope and content of the CAA's conformity provisions by providing a more specific definition of conformity. As stipulated in CAAA Section 176(c), conformity is defined as conformity to the State Implementation Plan (SIP) purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards. Conformity further requires that conforming activities will not:

(1) cause or contribute to any new violations of any standards in any area;

(2) increase the frequency or severity of any existing violation of any standards in any area; or

(3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

6.16.4.1 Transportation Conformity

The USEPA published final rules on transportation conformity that apply to the FHWA and the Federal Transit Administration (FTA) approved or funded highway and transit projects in areas designated non-attainment or maintenance for any of the criteria pollutants under the CAA (40 CFR Parts 51 and 93) rules were published in the November 24, 1993 *Federal Register* (revised on August 15, 1997). The USEPA rules require metropolitan planning organizations (MPOs) and the United States Department of Transportation (USDOT) to make a conformity determination on metropolitan transportation improvement programs (TIPs) before they are adopted, approved, or accepted. In addition, highway or transit projects that are funded or approved by the FHWA or FTA must be found to conform before they are approved or funded by DOT or an MPO. The project proposed by Empire, LTD is considered in New Jersey's TIP. The North Jersey Transportation Planning Authority (NJTPA), a metropolitan planning organization for the project area, has included the transportation component of the proposed project in its most recent RTP (Regional Transportation Plan) and TIP (FY 2002-2004). This action was approved by the NJTPA on October 1, 2001.

Roadway improvements for the construction alternatives considered would be Empire Tract internal access roadways with connections to the Route 120 Extension (a regional roadway connecting to the NJTA). These improvements would be privately funded by the applicant and classified as a non-federal project.

Approval for these roadway improvements would be required from the New Jersey Turnpike Authority (NJTA) and NJMC. Intersection signalization at four intersections within or near the Empire Tract boundary would require approval from NJDOT.

The NJDOT is a recipient of FHWA funding. NJDOT would be responsible for approval of signalization at four intersections. According to the transportation conformity rules (CFR 40 Section 93.127), intersection signalization projects are exempt from regional emissions analyses, only the localized hot-spot analysis applies. Furthermore, based on a discussion with the NJDOT Office of Major Access Permit (NJDOT 1998), approval of a signalization project proposed by a private developer is determined mainly based on 1) intersection progression and signal spacing criteria that would address both safety and clean air concerns, and 2) potential traffic impact on progression at other adjacent intersections (but not based on the transportation conformity rule).

6.16.4.2 General Conformity

USEPA published final rules on general conformity that apply to federal actions in areas designated non-attainment or maintenance for any of the criteria pollutants under the CAA (40 CFR Parts 51 and 93) in the November 30, 1993 *Federal Register*. The proposed rules provide specific *de minimis* emission levels by pollutant to determine the applicability of general conformity requirements for a proposed project. Generally, an analysis of project-related construction and operational period emissions is conducted to see if the *de minimis* emission levels are exceeded. If levels are determined to be below *de minimis*, no further analyses are necessary and a Record of Non-Applicability (RONA) is prepared. If *de minimis* levels are exceeded, a more detailed general conformity analysis is required. A general conformity determination also is required if emissions from a project are determined to be regionally significant. Under the general conformity regulations, regionally significant emissions are defined as emissions that equal at least 10% of the total non-attainment area emissions.

Since ozone is principally formed from nitrogen oxides (NO_x) and volatile organic compounds (VOCs) through a series of complex chemical reactions in the atmosphere, for the non-attainment area where the project is located, the following *de minimis* criteria would apply:

- 25 tons per year of VOCs or NO_x for a severe ozone non-attainment area;
- 100 tons per year of CO for a moderate CO non-attainment area.

Based on the general conformity rule, any direct and indirect emissions resulting from the proposed federal action and over which USACE has continuing program responsibility within non-attainment areas must be included in the general conformity applicability analysis. The emission sources include area, mobile, and stationary sources as well as construction activities.

The proposed action is a private development project and USACE federal action is limited to consideration of a permit for wetlands fill and mitigation activities. Thus, the calculation of emissions for the general conformity applicability determination also is limited to wetlands fill and mitigation activities based on the regulations at *40 CFR Parts 6, 51, and 93: Determining Conformity of General Federal Actions to State or Federal Implementation Plans, Final Rule (USEPA 1993).* The final rule states:

> "Where a USACE permit is needed to fill a wetland so that a shopping center can be built on the fill, generally speaking, USACE could not practicably maintain control over and would not have a continuing program responsibility to control indirect emissions from subsequent construction, operation, or use of that shopping center. Therefore, only those emissions from the equipment and motor vehicles used in the filling operation, support equipment, and emissions from movement of the fill material itself would be included in the analysis."

Additional pertinent guidance is provided in a general conformity directive issued by USACE in 1994. The directive provides guidance that indirect emissions that occur as a result of USACE permit actions, but which USACE could not practicably control, should be excluded from conformity determinations for USACE permit actions (USACE 1994).

For conformity purposes, the SIP applicable to the non-attainment area where the project would be located is the *State Implementation Plan (SIP) Revision for the Attainment and Maintenance of the Ozone National Ambient Air Quality Standards, Meeting the Requirements of the Alternative Ozone Attainment Demonstration Policy, Phase I Ozone SIP Submittal,* (NJDEP, December 1996, and revised October 2001). This SIP provided the most-recently projected emissions levels for CO, VOCs, and NO_x in the region.

To be a federally approved or sponsored project locating in a nonattainment area, the proposed actions need to comply with all requirements, emission thresholds, and offset criteria indicated in the General Conformity Rules.

Section 6.16 References

NJDEP (NJ Department of Environmental Protection). 1996. *Air Quality Analysis for Intersection (AQAI)*. Trenton, NJ.

NJDEP 1996. *State Implementation Plan (SIP)*. Trenton, NJ.

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6.17 HUMAN HEALTH

6.17.1 Regional Setting

Regional human health issues that can result from development include respiratory effects from air pollution (Section 6.16), carcinogenic and other health effects from toxic chemicals in soil and water (Sections 6.3 and 6.7), noise effects (Section 6.21), traffic accidents and other safety concerns (see Sections 6.14 and 6.15). These issues are discussed under their corresponding sections of the FEIS.

Regional health issues also include bans on consumption of fish from Newark Bay and the Hackensack River. New Jersey DEO Administrative Order EO-40-19 (August 6, 1984) prohibits sale or consumption of fish or shellfish taken from the tidal Hackensack River, but individuals have been observed fishing in tributaries (TAMS 1998).

Two liquified natural gas (LNG) storage tanks located off site on Transcontinental Pipeline (Transco) property, approximately 1,000 ft south of the New Jersey Turnpike Western Spur. These storage tanks have been operated safely without leaks, spills or explosions since their installation. State or local regulations do not require a minimum setback from these tanks. However, USACE has requested additional information from United States Department of Transportation (USDOT) and New Jersey Bureau of Public Utilities regarding the safety of these tanks, and their compatibility with future development on the Empire Tract.

The federal government sets safety standards for LNG storage tanks. USDOT Research and Special Programs Administration Regulations, 49 CFR Part 193, incorporate federal safety standards for liquified natural gas facilities. A LNG facility is defined in the regulations as a pipeline facility that is used for liquifying or solidifying natural gas or synthetic gas or transferring, storing, or vaporizing liquified natural gas. Subpart B of those regulations imposes siting requirements for the following LNG facilities: "Containers and their impounding systems, transfer systems and their impounding systems, emergency shutdown systems, fire control systems, and associated foundations support systems, and normal or auxiliary power facilities necessary to maintain safety." Section 193.2055 of the regulations requires the LNG facility operator to locate the facilities such that they are designed to minimize the hazards to persons and off-site property resulting from leaks and spills of LNG and other hazardous liquids at the site. These regulations were presumably followed when the tanks were originally constructed in their present location.

When constructed over 20 years ago, these tanks were likely sited according to federal regulations requiring an exclusion distance from nearby populated areas. Transco authorities did not respond to initial inquiries from USACE confirming the actual exclusion distance. Because the New Jersey Turnpike is located between the Empire Tract and the Transco property and was present prior to installation of the tanks, any required exclusion distance is likely not to extend beyond the Transco property.

USDOT 49 CFR Part 192 provides federal safety standards for the transportation of natural and other gas by pipeline. These regulations require a pipeline operator to meet specific design, construction, corrosion protection, testing, operational, and maintenance requirements.

According to Mr. Richard Huraux, Director of Pipeline Safety, USDOT, the department does not regulate the location of projects being developed near LNG facilities, such as the applicant's proposal (TAMS 1998).

According to Mr. David McMillan, Chief, Bureau of Pipeline Safety, New Jersey Board of Public Utilities, the board only regulates non-interstate pipeline facilities (TAMS 1998). The only local jurisdiction in New Jersey he was aware of that regulates distances from gas facilities is the Municipality of Edison, which requires a 75-foot separation distance.

6.17.2 Empire Tract

The Empire Tract consists mostly of wetlands and poses little health risk to surrounding communities. No significant sources of hazardous contamination have been documented on the site (see Section 6.7), and access to the site is limited. Like most wetlands in the Meadowlands, the Empire Tract wetlands have a high potential for mosquito larvae habitat and are, therefore, managed by the Bergen County Mosquito Control Division to control mosquito populations in order to reduce health risks. Due to the relatively undeveloped nature of the Empire Tract, the air and noise characteristics of the site can be considered similar to regionally measured conditions.

Section 6.17 References

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6.18 SOCIOECONOMICS

6.18.1 Demographics

6.18.1.1 Bergen County and HMD

Population and Household Size

The Empire Tract is located within the Hackensack Meadowlands District (HMD) and the Borough of Carlstadt. Portions of the site also fall within the Township of South Hackensack. Bergen County overlaps with the northern part of the HMD, while the southern part of the HMD is located within Hudson County. This discussion focuses on Bergen County, as it is the county in which the proposed project site is located.

Both the population and number of households increased steadily in Bergen County over the first seven years of the 1990s, and started to reverse the population decrease during the previous decades (1970 to 1990). Population increased by 4.2% from 825,380 people in 1990 to 860,210 people in 2000. During the same period, households increased by 6.1% from 308,880 in 1990 to 327,1873 in 2000. These figures are illustrated in Table 6.18-1.

On a local scale, the estimated population in the HMD was 15,154 persons in 1988, based on a land use survey of housing units conducted by NJMC. This is relatively low, considering the area's location between employment opportunities in New York City, urban centers in New Jersey such as Newark, and high-density residential areas in northern New Jersey. As of 1988, 1% of the combined population of Bergen and Hudson counties lived in the HMD. This reflects the area's predominant land uses, consisting of undeveloped areas of wetlands and surface waters, businesses related to land uses, transportation corridors, and other nonresidential land uses.

Population estimates for 1980 and 1988 indicate a population growth of 13.6% over the 8-year period, with the population in the HMD increasing from 13,340 in 1980 to 15,154 in 1988. During the same period, the population in Bergen County and Hudson County declined (USEPA and USACE 1995).

Population growth during the 1990s in the HMD may be the result of a greater inventory of vacant land suitable for residential development relative to other parts of Hudson and Bergen counties. Trends starting at the end of the 1980s indicated a reversal of the population decline and a shift towards moderate growth in Bergen County. This trend has since continued.

Table 6.18-1
Bergen County Population and Income Size

Bergen County	1990	2000	1990 - 2000 Percent	Annual Growth
Population	825,380	860,210	4.2%	0.42%
Households	308,880	327,873	6.1%	0.61%
Average Household Size	2.64	2.60	(1.5%)	(0.15%)
Source: CACI Marketing Systems				

Income and Income Distribution

Between 1990 and 2000, average household income in Bergen County increased by 56.2%, from $63,934 in 1990 to $99,880 in 2000. Over the same period per capita income has experienced similar growth, a 58.9% increase from $24,080 in 1990 to $38,272 in 2000. Tables 6.18-2 and 6.18-3 illustrate the respective incomes and changes for Bergen County.

Table 6.18-2
Bergen County Income and Income Distribution

Bergen County	1990	2000	1990 - 2000 Percent	Annual Growth
Average Household Income	$63,934	$99,880	56.2%	5.62%
Per Capita Income	$24,080	$38,272	58.9%	5.89%
Notes: Source: CACI Marketing Systems				

Table 6.18-3
Bergen County Income Distribution

Household Income Distribution	2000 Percent	2005 Projected Percent
Less than $15,000	7.0	6.0
$15,000 - $24,999	6.0	5.0
$25,000 - $34,999	8.0	7.0
$35,000 - $49,999	14.0	13.0
$50,000 - $74,999	22.0	22.0
$75,000 - $99,999	15.0	15.0
$100,000 - $149,999	15.0	17.0
$150,000 +	12.0	15.0
Source: CACI Marketing Systems		

Employment

Services, manufacturing, and retail trade dominate the Bergen County economy. Manufacturing has traditionally been the highest employer, but with a shift in economic concentration, the services industry has become the largest employer in the county. The shift in employment from manufacturing jobs to other sectors is similar to that shown for New Jersey, and also nationally. In 2000, total employment in Bergen County was 572,380 persons, a 4.2% increase since 1990. In 2000, services accounted for 34.6% of the total employment, followed by retail trade at 14.1% and manufacturing at 11.9%.

Projections through 2005 indicate that the services sector will continue to dominate the economy and that manufacturing will continue to decrease. The only strong increases projected are for the financial, insurance and real estate sector, which is expected to increase 3.0 %, and for the services sector, which is projected to increase 6.7 % over the years 2000-2005. The employment base is expected to grow in the same period at an annual rate of 0.45% to 585,410 in 2005 (Table 6.18-4).

Table 6.18-4
Bergen County Total Employment

1990	2000	2005 Projected
549,040	572,380	585,410
Source: Woods & Poole Economics, Inc.		

6.18.1.2 Borough of Carlstadt

Population and Household Size

Both the population and number of households increased slightly in Carlstadt between 1990 and 2000. During that period, population increased at an annual rate of 0.3% from 5,510 people in 1990 to 5,684 people in 2000. During the same period, households increased by 0.5% annually from 2,192 in 1990 to 2,301 in 2000. These figures are illustrated in Table 6.18-5.

Table 6.18-5
Borough of Carlstadt Population and Household Size

Carlstadt	1990	2000	1990-2000 Percent	Annual Growth
Population	5,510	5,684	3.02%	0.30%
Households	2,192	2,301	5.00%	0.50%
Average Household Size	2.51	2.47	(1.6%)	(0.16%)
Source: CACI Marketing Systems, Ernst & Young calculations				

Income and Income Distribution

Between 1990 and 2000, average household income in Carlstadt increased by a total of 49.1% and an average rate of 4.9% annually, from $44,290 in 1990 to $66,057 in 2000. Over the same period, per capita income experienced similar growth, 49.6% total and 4.96% annually, increasing from $17,873 in 1990 to $26,741 in 2000. Tables 6.18-6 and 6.18-7 illustrate the respective incomes and changes for Carlstadt.

Table 6.18-6
Borough of Carlstadt Income and Income Distribution

Carlstadt	1990	2000	1990 - 2000 Percent	Annual Growth
Average Household Income	$44,290	$66,057	49.1%	4.91%
Per Capita Income	$17,873	$26,741	49.6%	4.96%

Source: CACI Marketing Systems

Table 6.18-7
Borough of Carlstadt Income Distribution

Household Income Distribution	2000 Percent	2005 Projected Percent
Less than $15,000	8.3	6.3
$15,000 - $24,999	8.4	7.4
$25,000 - $34,999	8.5	8.4
$35,000 - $49,999	20.1	13.9
$50,000 - $74,999	25.3	28.7
$75,000 - $99,999	16.6	16.8
$100,000 - $149,999	8.5	12.5
$150,000 +	4.3	5.9

Source: CACI Marketing Systems

6.18.2 Community Facilities

The following describes the various community facilities located within the HMD, within Carlstadt, and within the immediate vicinity of the Empire site. Many of the facilities serve the entire HMD or large parts of the HMD rather than a specific community. Community facilities are often located in residential areas. Since the HMD has a relatively low residential population and these facilities are thus often located at the periphery of the HMD. Figure 6.18-1 provides an overview of the community facilities within the HMD.

6.18.2.1 Recreation

The Hackensack River provides the main open space resource in the HMD, supporting active and passive recreation, including trails, marinas and waterfront parks. Although much of the open space in the Meadowlands is privately owned, and not publicly accessible, these open space areas do contribute to the aesthetic qualities of the HMD.

The Richard W. De Korte Park, located in the southern portion of the Meadowlands, is one of the larger dedicated public open spaces in the area. Within the park, the NJMC Environment Center is one of the major features dedicated to recreational and educational use in the context of ecological restoration. Specific recreational facilities consist of trails and canoe areas. Trails include the Transco Trail, a public/private project that uses the gas pipeline utility roadway as a public nature trail.

The Meadowlands Sports Complex is located approximately 1,500 ft southwest of the Empire Tract. This facility is the largest recreational facility within the HMD. It has a regional recreational function, which serves the entire New York/New Jersey Metropolitan Region. The complex includes a racetrack; Giants Stadium, used for professional football and other exhibitions; and the Continental Airlines Arena, which provides indoor space for professional hockey, basketball, exhibitions, and musical performances.

North of the Empire Tract is Losen Slote Park, located in the municipality of Little Ferry, at a distance of approximately 8,000 ft from the site. This is a 22-acre park with a nature preserve and active recreational facilities, including a roller rink. Also in the vicinity is Snipes Park, a small 18-acre park with a pedestrian trail along the east bank of the Hackensack River, located approximately 8,000 ft southeast of the Empire Tract.

As of 1995, the total land area dedicated to parkland within the HMD was 825 acres. With the exception of the Meadowlands Sports Complex and DeKorte Park, the majority of existing recreational facilities are in the Secaucus area.

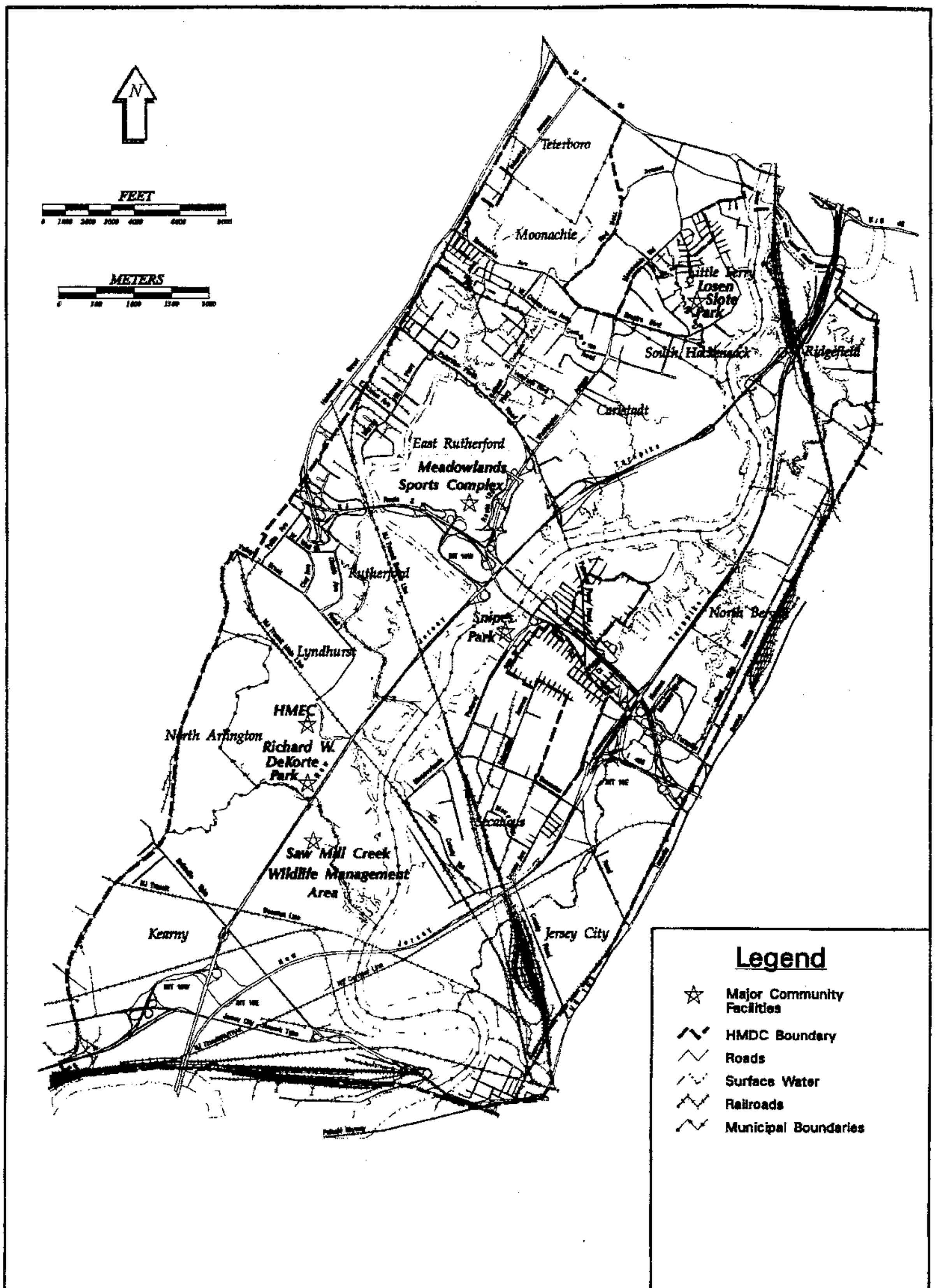

Figure 6.18-1

Major Community Facilities

Source: USEPA and USACE, 1998

6.18.2.2 Education

Several educational facilities are located within the HMD. In East Rutherford there is a regional high school (grades 9-12) and Lincoln Elementary School (grades K-4). In Secaucus there is Clarendon Elementary School (grades K-6), Secaucus Middle-Secondary School (grades 7-12) and Secaucus High School (grades 7-12). Educational facilities in Little Ferry include Washington School (grades K-2) and Memorial School (grades 3-8). Education facilities in Moonachie include the Robert L. Craig School (grades K-8), and the Grant School (grades K-6). Within Carlstadt there are three public schools serving kindergarten through sixth or eighth grade (see Table 6.18-8).

Two day-care centers/nursery schools are located in Secaucus. Employers in the HMD may also offer day care facilities to their employees.

Table 6.18-8
Borough of Carlstadt Public Schools

School	Grades Served	Number of Students
Lincoln School 550 Washington Street	Pre-K - 6th	134
Lindberg School 503 6th Street	Pre-K - 6th	110
Washington School 326 3rd Street	Pre-K - 8th	288
Total		**532**
Source: Superintendentof Schools, Borough of Carlstadt, 1997.		

The combined 1997-1998 student capacity of these three schools (Table 6.18.8) was 809, with a total enrollment for the 1997-1998 school year of 532 students. The number of books in the libraries of the three schools totaled 25,400 volumes. The 1994-1995 school budget, excluding payments on debt, was $5.03 million, with base spending amount per student at $8,447. This amount does not include costs of such items as capital expenses and transportation. All the schools are located 2 miles or more west of the Empire Tract.

Carlstadt high school students attend the Henry P. Becton Regional High School, located off Route 17 in East Rutherford, 2.5 miles west of the Empire Tract. During the 1995-1996 school year, the total student population numbered 409, although the school capacity was 1,000 students. Of this total, 191 were Carlstadt residents. The school library contained approximately 21,700 volumes.

The 1994-1995 budget for this regional high school was $6 million, with base spending per student at $12,368 (E&Y 1998).

6.18.2.3 Community Center

The Carlstadt Civic Center occupies the second floor of the Volunteer Ambulance Corps building, which is located at 424 Hackensack Avenue. Barrier-free access to the hall is from 4th Street. Each Wednesday one of two senior citizens' groups holds a meeting at the center. The two groups, the Senior Center, Inc. (organized in 1961) and the Senior Friendship Club (organized in 1979), have a total membership of approximately 200 senior citizens.

6.18.2.4 Library

Carlstadt's library, the William E. Dermody Free Public Library, contains approximately 30,000 books and is located at 410 Hackensack Street, adjacent to the Volunteer Ambulance Corps building.

6.18.2.5 Police

The Borough of Carlstadt Police Department headquarters is located in the Municipal Building at 500 Madison Street. There is approximately one police officer for every 210 Borough of Carlstadt residents. As in other parts of the HMD, police protection is also provided to employment areas where no residents live. County roads are also patrolled by the Bergen County Police Department.

In 1997, the Borough of Carlstadt's total expenditure for municipal functions was $11.75 million, of which 20.17%, or $2.37 million, was allocated for police protection (E&Y 1998). The 2000 budget increased expenditures on police protection to $2.63 million, or 21% of the total municipal budget of $12.52 million (E&Y 2001).

In 1995, there were a total of 324 crimes reported to the police in Carlstadt. Of these, 313 were considered non-violent and 11 were violent crimes. The number and categories of the non-violent crimes consisted of 201 cases of larceny, 67 motor vehicle thefts, and 45 burglaries. The violent crimes consisted of nine aggravated assaults and two robberies. In the one-year period between 1994 and 1995, the number of violent crimes declined 21.4%. In 1994, there were a total of 14 violent crimes and 285 non-violent crime cases reported within the borough. (Source: The New Jersey Department of State Police.)

6.18.2.6 Fire Department

Municipal fire departments in the HMD are all operated on a voluntary basis, with the exception of the Jersey City, Kearny and North Bergen departments. Teterboro, located northwest of the site, contracts with the Borough of Hasbrouck Heights for fire protection. Fire protection is provided to businesses within the HMD, as well as to residences.

The Carlstadt Fire Department operates from two fire stations. The main fire station, with five bays, is located on the lower floor of the municipal building and has access to Jefferson Street. An aerial platform truck is housed at the main fire station, along with two engines, a snorkel, a heavy rescue truck, and a rescue boat. The other firehouse, a two-bay facility, is located on Washington Avenue, just south of Veterans Boulevard. One engine and the reserve pumper are stationed there. The Carlstadt Police Department dispatches the Fire Department.

The Carlstadt Fire Department also belongs to the South Bergen Mutual Aid Group, which is called upon when additional personnel and equipment are needed in a fire emergency. The Mutual Aid Group is comprised of 16 municipal fire departments and more than 60 pieces of fire fighting equipment. In the 2000 Carlstadt municipal budget, $366,242, or 2.9% of the $12.52 million located for municipal functions, was assigned for fire protection.

6.18.2.7 Hospitals and Ambulance Services

Four hospitals are located in or adjacent to the HMD. Two of these are located approximately 8 miles southeast of the site in Secaucus: the Meadowlands Hospital and the Meadowlands Hospital Medical Center (230-bed facility) on the Meadowlands Parkway; and Meadowview County Hospital (400-bed facility) on County Avenue. The Hackensack University Medical Center (614-bed facility) is located on Prospect Avenue in Hackensack. The West Hudson Hospital (250-bed facility) is located on Bergen Avenue in Kearny, just outside the Meadowlands District.

The Carlstadt Volunteer Ambulance Corps is located at 424 Hackensack Avenue. Volunteers man the two ambulance vehicles stationed at this two-bay facility. A three-person crew is assigned to each vehicle. Each crew is assigned to a 12-hour shift, which changes at 6:30 am and 6:30 p.m.

There are no hospitals located within Carlstadt. The primary emergency hospital used by the Ambulance Corps is the Hackensack University Medical Center, located at 30 Prospect Avenue, Hackensack, approximately 4 miles north of the Ambulance Corps building. This medical center is the major acute care facility in the area. In 1996, the Emergency/Trauma Department treated 50,155 patients.

The secondary emergency hospital used by the Ambulance Corps is the Meadowlands Hospital Center, located on Meadowlands Parkway in Secaucus. This 230-bed facility is located about 5 miles east of the Ambulance Corps building. The Corps also uses Passaic General Hospital, located about 5 miles to the west in the city of Passaic.

6.18.2.8 Religious Facilities

Religious facilities in or adjacent to the HMD include St. Joseph's Roman Catholic Church at Hackensack Street and Hoboken Road in East Rutherford; English Neighborhood Reformed Church at Edgewater Avenue and Church Place in Ridgefield; Good News Bible Mission on Dales Avenue in Jersey City; New Durham Baptist on Tonelle Avenue, Holy Trinity Lutheran on Liberty Avenue, Grove Reformed Church on 46th Street, and the Church of Our Savior on 191 State Highway #153, all in North Bergen; and St Matthew's Lutheran on Roosevelt Avenue and Paterson Plank Road, First Reformed Church of Secaucus on Center Avenue, and Immaculate Conception on Paterson Plank Road, all in Secaucus (USEPA and USACE 1995).

6.18.3 Fiscal

6.18.3.1 Bergen County Budget

For 2000, Bergen County's total allocated budget of $302,584,449 is detailed in Table 6.18-9.

Table 6.18-9
Bergen County 2000 Budget

Services	Cost
Public Safety	$11,481,020
Health and Human Services	$21,984,389
Public Works	$15,034,471
Mental Patients in State Institutions	$23,938,980
Educational Agencies	$35,531,603
Debt Service and Capital Improvements	$39,008,682
General Government	$155,605,304
Total	**$302,584,449**
Source: 2000 County of Bergen Budget, Calculations by Ernst & Young	

Bergen County's estimated resident population in 2000 was 860,210 persons; the total number of workers employed in the County was 572,380. Some of the expenditures above, such as Health and Human Services, relate specifically to the resident population. On a per-resident basis, such services amounted to $128.14 per capita in 2000.

All the other services listed above, such as public safety and general government, related to the combined resident and worker populations. Calculating from a total base of 1,432,590 residents and workers, worker expenditures amounted to $103.65 per capita in 2000.

In 2000, 64% of the County's budget was funded by local taxation, 10% was funded by various user fees and local revenues (such as court fees, permit fees, licenses, etc.), and 11.6% was funded through state aid and state/federal grants. The balance was funded by the prior year's surplus and interest earned. The County receives its tax revenues as a lump sum payment from each of its 74 municipalities, according to the office of the County Tax Administrator.

6.18.3.2 Carlstadt Municipal Budget

For 2000, Carlstadt's total budget for municipal expenditures, excluding schools, was $13.8 million in revenues, and $12.52 million in expenses (with $530,000 in surplus). The expenses are detailed in Table 6.18-10.

Table 6.18-10
Borough of Carlstadt's 2000 Budget

Services		Cost
Public Safety:	Police Protection	$2,625,166
	Fire Protection	$366,242
	Other (First aid, emergency, etc.)	$60,832
Health Services		$72,101
Streets & Roads		$437,529
Sanitation		$478,511
Recreation & Education		$177,198
General Government		$8,304,724
Total		**$12,522,303**
Source: Borough of Carlstadt, Calculations by Ernst & Young		

Carlstadt's estimated resident population in 2000 was 5,684 persons; the total number of workers employed in the Borough was estimated at 18,389. Health services, recreation, and education expenditures as indicated above, related specifically to the resident population. On a per-resident basis, these services amounted to $43.86 per capita in 2000.

All the other services listed above, including public safety, streets and roads, sanitation, and general government, related to the combined resident and worker population. Calculating from a total base of 24,073 residents and workers, expenditures amounted to $480.14 per capita.

In order to calculate per-capita expenditures accurately, an individual should be accounted for in terms of capacity, as a resident, a worker, or both. This may seem to involve double-counting as represented by adding these two groups together. However, this is appropriate since as long as an individual lives and works within the borough, that person generates a requirement for public services in two different capacities. For example, the individual's residence would require police protection and sanitation services, as would the individual's workplace.

In 2000, 75% of the Borough's budget was funded by taxes and 5.7% by various user fees and miscellaneous revenues (such as fines, permit fees, etc.). State aid/grants, and other miscellaneous sources funded the balance.

The total tax revenue realized in 1997 for Carlstadt was $9.4 million. Although specific tax revenue from businesses is not reported or recorded by the Borough of Carlstadt, businesses made up approximately 75% of the total assessed value of real property in the Borough. It is therefore estimated that approximately $7.05 million of Borough tax revenues for 2000 could be attributable to businesses.

6.18 References

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6.19 NAVIGATION

6.19.1 Water

The Empire Tract is situated along the west side of the Hackensack River, between river miles 9.1 and 11.8. (River mile 0 is at Newark Bay). USACE maintains a 32-foot-deep Federal Navigation Channel up to river mile 4. Above this point, including the reach adjacent to the Empire Tract, the channel is authorized for dredging to a depth of 15 ft.

While the river reach from mile 4 to mile 16.5 is nominally maintained at a 15-ft depth, at some locations the minimum depth at low water is actually less than 15 ft, based on soundings of the various reaches of the Hackensack River performed by USACE in 1990, 1992, and 1996. Commercial vessels with a draft of no more than 14 ft routinely use the channel between river miles 9.1 and 11.8 near the Empire Tract. There are no federal navigational channels located on the Empire Tract.

The tide gates and dikes, established in the early part of the twentieth century, have precluded boat traffic on the Hackensack River from entering the creeks on the Empire Tract.

6.19.2 Air

Current air navigation activity in the vicinity of the Empire Tract is primarily associated with Teterboro Airport, which is located 1.5 miles north of the site, in the Boroughs of Teterboro and Moonachie, New Jersey. Air traffic to Teterboro Airport consists primarily of corporate and private jets accessing northern New Jersey locations and nearby New York City, and commercial air freight operations. There are approximately 150,000 plane movements at Teterboro Airport annually.

As a result of flight operations, the FAA has imposed height restrictions on development to the south of the Teterboro Airport runway. A general height restriction of 158.5 ft above MSL is imposed on the majority of the Empire Tract due to its location within 10,000 ft of the airport.

6.20 LAND USE AND ZONING

6.20.1 Land Use - Regional Setting

Figure 6.20-1 provides an overview of land usage within the HMD, including land uses in the northwestern portion of the District in which the site is located. Figure 6.20-2 shows the land uses in the area surrounding the Empire Tract, extending between 2 and 3 miles. The area comprises a mix of land uses: residential, industrial, commercial, utility, and transportation uses, as well as areas of undeveloped open space and wetlands extending along the Hackensack River.

6.20.1.1 Introduction

Generalized land uses surrounding the Empire Tract include transportation, sports facilities and recreation, light industry and commercial complexes, as well as residential uses and undeveloped areas.

6.20.1.2 Transportation

The Empire Tract is located within a mile of several state and federal highways. The site is located immediately south of the New Jersey Turnpike (I-95), where it diverges into eastern and western spurs on either side of the Hackensack River. To the west of the Empire Tract are Routes 17 and 21, which are important north-south state thoroughfares. North of the site are Interstate 80 and Route 46, important east-west thoroughfares. To the south, Route 120 is immediately adjacent to the Empire Tract and extends to Route 3. Route 3 connects many of the major highways in northern New Jersey to I-495, with access to the Lincoln Tunnel and New York City. Commerce Boulevard, Empire Avenue, Paterson Plank Road, and Washington Avenue are local thoroughfares that border the Empire Tract and are used to meet local business and travel needs.

Mass transit in the area is presently provided by local and commuter buses. Commuter rail lines are located several miles to the north and south of the Empire Tract. Newark International Airport is located 10 miles to the south, and Teterboro Airport is located approximately 1.5 miles to the north. Further information on transportation is provided in Section 6.14.

6.20.1.3 Recreation

The Meadowlands Sports Complex is located immediately southwest of the Empire Tract. The complex is comprised of Giants Stadium, the Continental Airlines Arena, and the Meadowlands Racetrack. These facilities provide venues for professional sporting events, conventions, harness racing, concerts, fairs, and other large-scale events.

Along the Hackensack River, adjacent to the Empire Tract's 42-acre parcel, is the Barge Club Marina, which also includes a restaurant and golf facilities.

6.20.1.4 Commercial and Industrial

Commercial and industrial facilities in the HMD are concentrated within the flat areas of the HMD. Light industrial facilities and warehouses abut the Empire Tract to the west. The area between the western boundary of the site and Washington Avenue is developed primarily with large office/warehouse complexes along Commerce Boulevard, Empire Boulevard, and State Street; the remainder of the area between the site and Washington Avenue is developed mostly with a mix of older commercial and industrial uses. The Bergen County Utilities Authority sewage treatment facility is located to the north of the Empire Tract.

6.20.1.5 Residential Uses

Residential areas in the vicinity of the Empire Tract are located along the high ridges to the east and west of the Hackensack River, about 2 miles from the Empire Tract, and at the town of Secaucus, located approximately one mile to the south across the Hackensack River, and Little Ferry and Moonachie, located about a mile to the north. Residential areas surrounding the Empire Tract also include Carlstadt, East Rutherford and Hasbrouck Heights, located 2 miles to the west.

6.20.1.6 Coastal Zone Management Plan Consistency Determination

The August 1980 *New Jersey Coastal Management Program and Final Environmental Impact Statement* prepared by the NJDEP defines the HMD as a particular area of geographic concern. The New Jersey state legislature has adopted statutes that designate the NJMC as the lead state agency in the HMD. Coastal Zone Consistency determination is delegated from the Federal level to the NJDEP at the state level. The New Jersey Coastal Management Program recognizes the NJMC as the lead coastal planning and management agency for the HMD. NJDEP determines consistency with the state's Coastal Zone Management Plan based on the findings from the NJMC that projects conform to the NJMC zoning and regulations in the HMD.

6.20.2 Land use - Empire Tract

The Empire Tract is comprised of approximately 587 acres of currently undeveloped land, open water and wetlands. The site is divided into two parcels of land, measuring 545 acres and 42 acres, respectively. The 545-acre parcel comprises land north of Interchange 18W of the New Jersey Turnpike in Bergen County, New Jersey. The 42-acre parcel, to the southeast of the larger parcel, is separated from the larger parcel by the western spur of the New Jersey Turnpike, and borders on the Hackensack River. Most of the Empire Tract is within the Borough of Carlstadt,

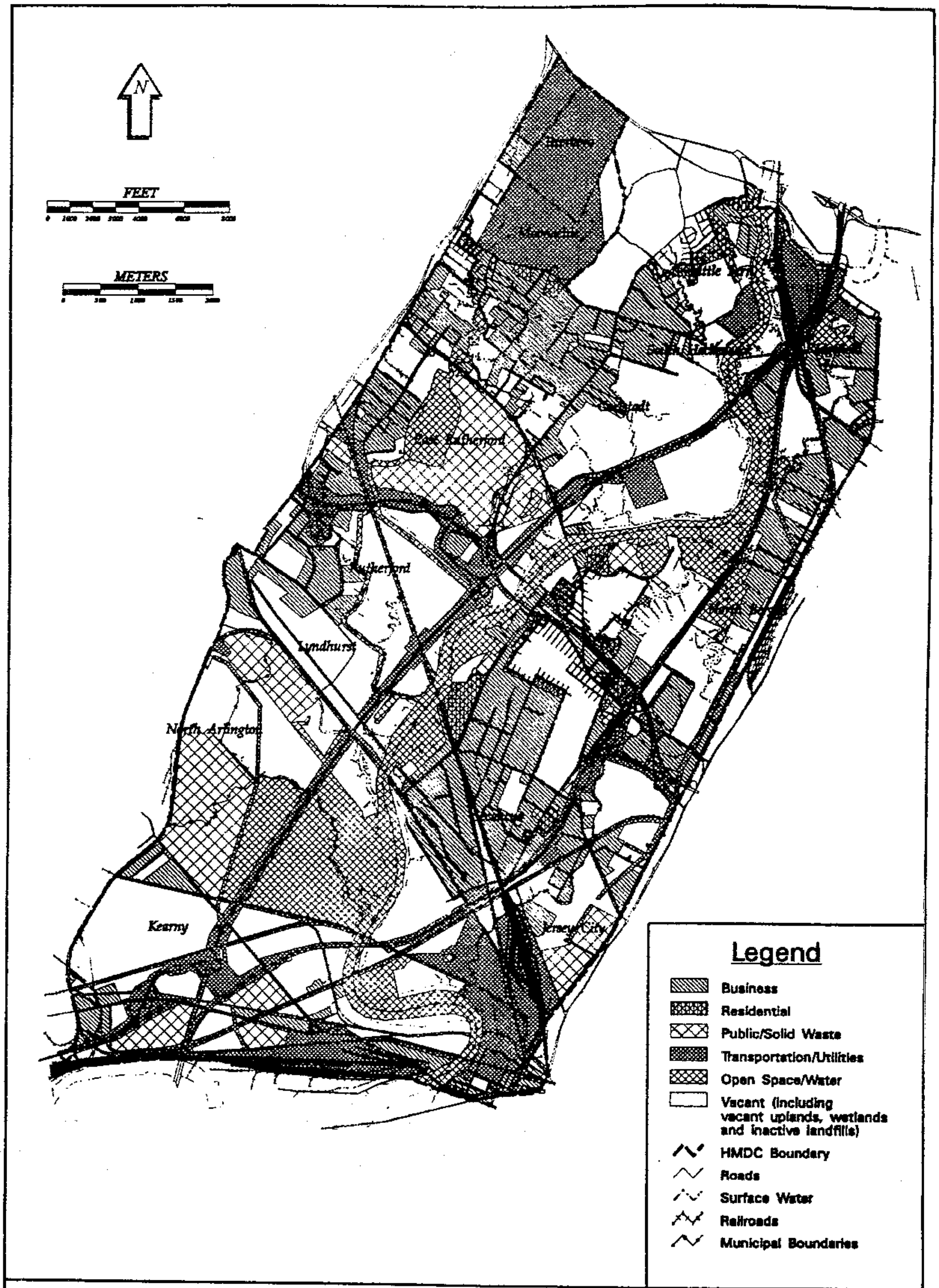
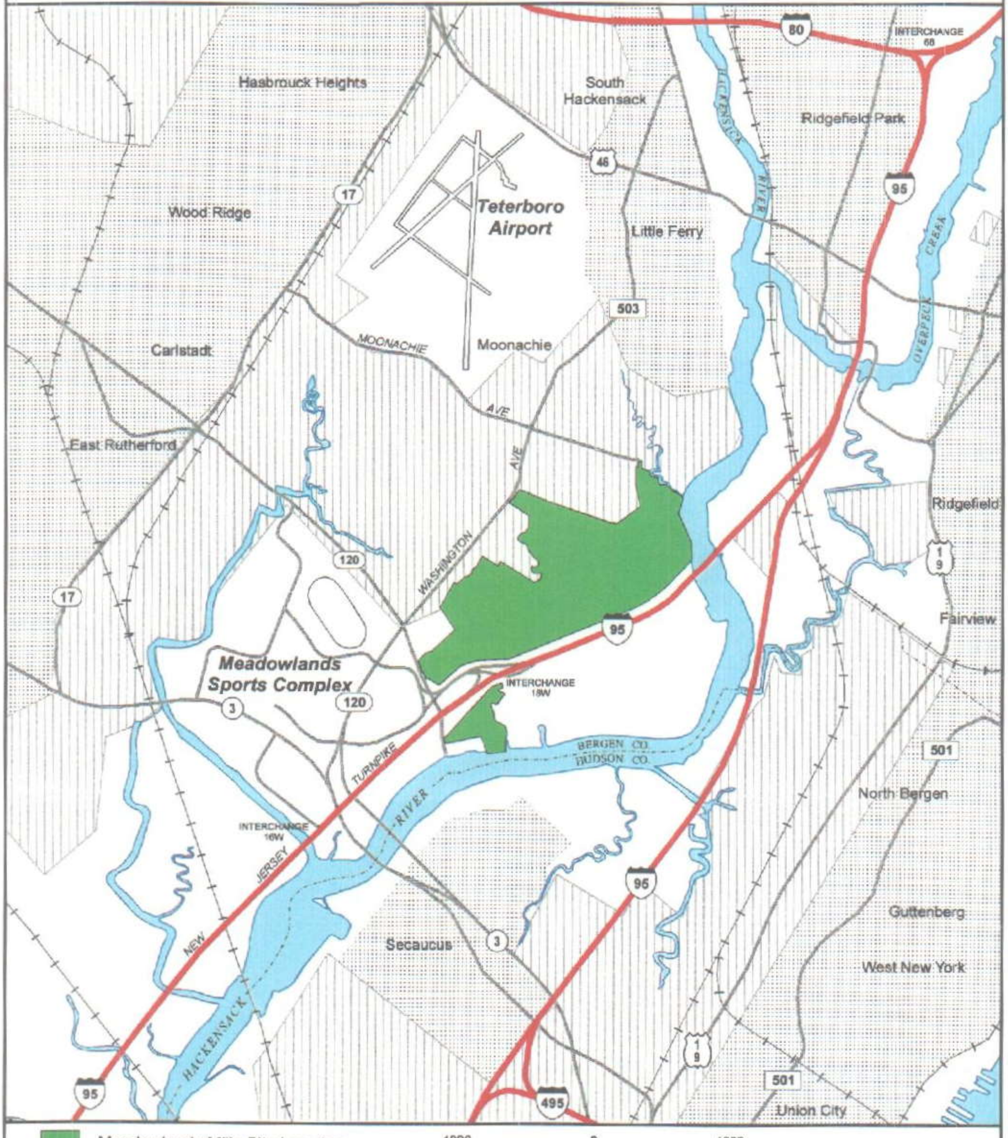


Figure 6.20-1

Generalized Land Use in the Hackensack Meadowlands District

Source: USEPA and USACE, 1995

Generalized Local Land Use



Meadowlands Mills Site Location

Commercial, Light Industrial, Utility

Residential

Open Space and Other

4000 0 4000

Scale in Feet

1000 0 1000

Scale in Meters

N

Figure 6.20-2

Bergen County; however, the most northerly portions of the 545-acre parcel extend into the municipalities of South Hackensack and Moonachie, New Jersey. Both parcels of land are owned by Empire, Ltd.

6.20.2.1 On-Site Uses

A section of the Transco transcontinental gas pipeline extends underground across the northern portion of the Empire Tract. Built in 1953, the pipeline is a series of pipes and receiver stations that transport natural gas from the Gulf of Mexico to the northeast region of the United States. The portion of the pipeline located on the Empire Tract is referred to as the Paterson Lateral. This section of pipeline carries natural gas from the Leidy storage facility in Clinton County, Pennsylvania to Transco's receiver facility at Paramus, New Jersey. The pipeline, which measures 30 inches in diameter and is constructed of steel, is located within an easement that is about 50 ft wide and 4,000 ft long. Part of the easement consists of a dirt road that provides access for service vehicles to monitor and maintain the pipeline (Morgensen 1997).

6.20.3 Zoning

6.20.3.1 Regional Setting

The HMD is comprised of various zoning districts, reflecting a range of land uses and densities within the HMD. Figure 6.20-3 presents the geographic distribution of the various zoning districts within the HMD. Table 6.20-1 provides a description of the types of land uses associated with each zoning designation.

The Empire Tract is comprised of several zoning areas designated by the NJMC. Figure 4.2-1, (Chapter 4) and Table 6.20-2 illustrate the location of the various tracts that make up the project site and describe their land use type by tract.

The majority of the Empire Tract (Tracts 1 and 2) is zoned Planned Development Center (PDC-1). PDC-1 is a specially planned area that incorporates mixed uses. Principal uses permitted in the PDC-1 zone include office, regional and neighborhood retail, commercial, hotel and residential. Accessory uses may include, but are not limited to, public facilities, transportation facilities, parking structures and open space.

Portions of the Empire Tract adjacent to the PDC-1 zone are zoned Light Industrial (Tracts 3 and 4). Tracts 3, 4 and 5 are zoned Light Industrial B, while Tract 4, which is adjacent to Tract 5, is zoned Light Industrial A. Both Light Industrial A and B zones allow for the application of Planned Unit Development (PUD). Light Industrial A is designated for a variety of industrial, distribution, commercial, and business uses on large lots. Light Industrial B is similar to Light Industrial A, but allows smaller lot sizes.

A small portion of the Empire Tract, Tract 6, located at the intersection of Empire Boulevard and State Street, is zoned Park and Recreation.

Table 6.20-1
New Jersey Meadowlands Commission
Zoning Categories

Zone	Acreage	Description
Marshland Preservation	1,750	Primarily located in the Saw Mill Creek watershed. Designed to preserve and enhance ecological values to preclude development and urbanization inconsistent with natural environment. Activities that may impair marshland quality or interfere with the use of this area as a habitat are prohibited.
Park and Recreation	1,100	Located in North Arlington, Kearny, and Lyndhurst at the site of the proposed DeKorte State Park, and smaller tracts north of Secaucus and along the eastern margin of Teterboro Airport.
Planned Park and Recreation 1	80	Purpose is to allow residential and commercial development on privately owned, non-riparian-claimed property located within the area designated as DeKorte State Park. Permits development that complements park uses. Among permitted uses for the zone are a maximum of 900 residential units (townhouse/multi-family) and hotel or similar development not to exceed 500 rental units.
Low Density Residential	310	Primarily located in Little Ferry along the northern District boundary and in north Secaucus along the out-of-District "islands". Most in use as low-density housing. Minimum lot area: 5,000 square feet for single-family and two-family houses and 2,000 square feet per multiple-family dwelling unit. Open space minimums for single- and two-family dwellings are 50%; multiple-unit dwellings are 35%.
Waterfront Recreation	70	Limited to four small tracts on the Hackensack River in the center of the District. Allowable uses: restaurants and hotels when included with a marina. Marinas are to be public facilities providing launching, mooring and parking to their users. Also permits residential uses. Environmental performance standards are stringent for source particulate emissions.
Highway Commercial	380	Allowable uses include: banks and businesses, medical offices, restaurants and theaters and other accessory uses. Strip development to be avoided. Locations include the large corridor along Route 3 (between the eastern spur and the Hackensack River) and a narrow band adjacent to the eastern spur of the Turnpike in the southern part of the District.
Service Highway Commercial	70	Permits uses of a business and commercial nature but suggest auto-related businesses. Located along the NJ Route 3 corridor.
Research Park	200	Locations area west of Penhorn Creek and east of the eastern spur of the Turnpike in Jersey City and area along Chromakill Creek in North Bergen. Designated for research and office facilities in a park-like environment with substantial amounts of landscaped open space. Warehouses are also allowable.

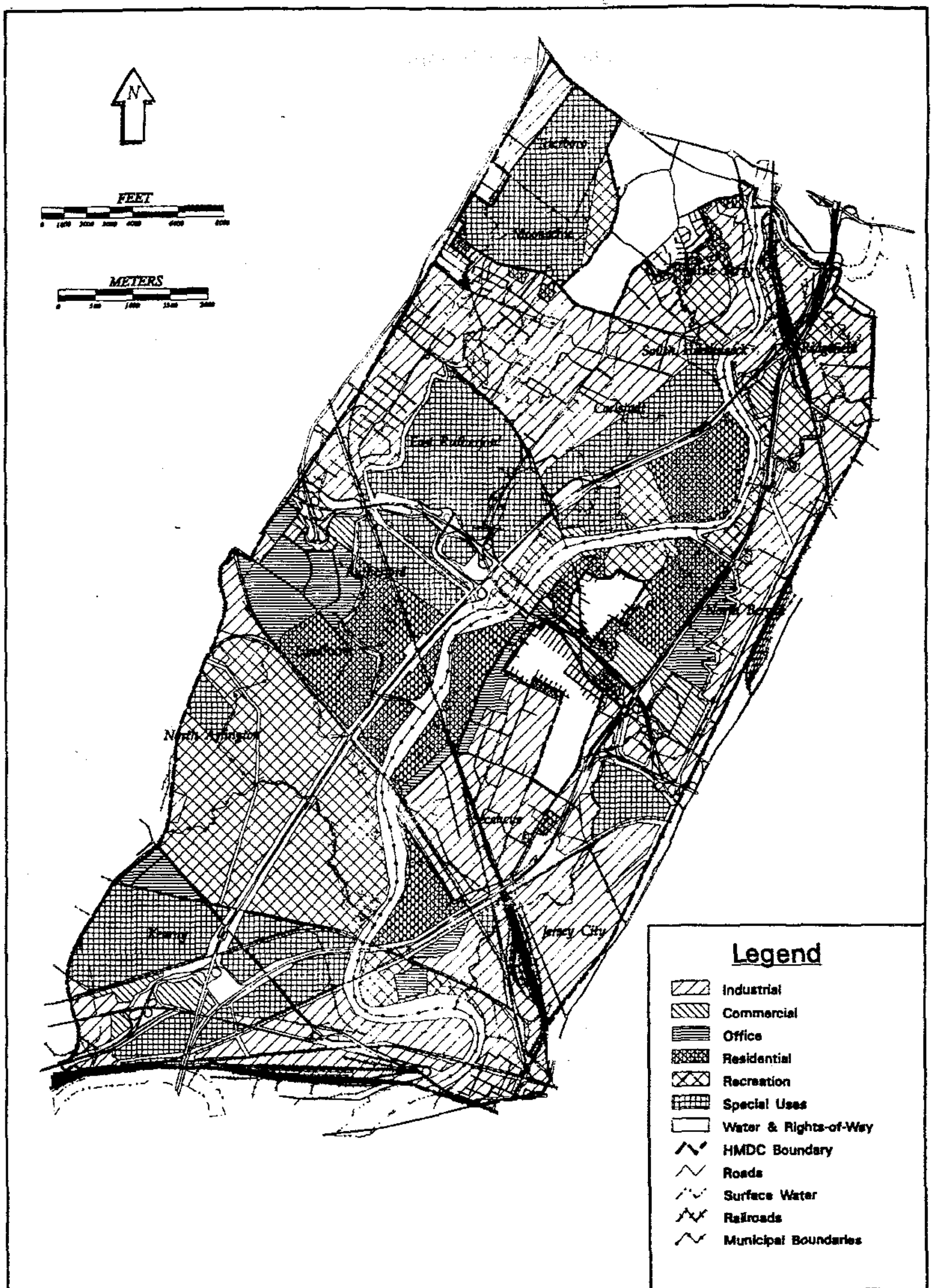


Figure 6.20-3

Generalized Zoning within the Hackensack Meadowlands District

Source: USEPA and USACE, 1995

Table 6.20-1-continued
New Jersey Meadowlands Commission
Zoning Categories

Zone	Acreage	Description
Research Distribution Park	590	Similar to the Research Park zone, but manufacturing and incidental uses also allowed. Located at the western side of the District in Lyndhurst and in triangle formed by the Belleville Turnpike, the western boundary of the District and the NJ Transit Mainline.
Light Industrial A	1,960	Designated for variety of industrial, distribution, commercial, and business on large lots. Includes most of the southern half of Secaucus, the northern section of Jersey City, and most of East Rutherford adjacent to the Sports Complex, tracts in eastern Carlstadt, and a strip between the PATH yards and the Turnpike at the extreme southern end of the District.
Light Industrial B	2,550	Similar to Light Industrial Zone A, but allows smaller lot sizes. Locations comprise most of Carlstadt, scattered sections along NJ Route 3 on the eastern District border, a narrow strip running along most of North Bergen's District border, tracts located in Ridgefield along Bellman's Creek, and in the extreme northwest corner of the District flanking Teterboro Airport.
Heavy Industrial	1,410	Accomodates industrial uses that are not appropriate in other industrial zones. In addition to light industrial uses, permitted uses include meatpacking, construction materials, cartage, motor freight terminals, railroad yards, resource recovery systems and various automobile-related facilities. Located primarily in the southeastern sector of the District, also along the fringes of the District in North Bergen, Kearny, Ridgefield and Lyndhurst.
Airport Facilities	700	Designated for aviation uses and uses customarily associated with an airport facility. Coincident with Teterboro Airport in the northwest corner of the District.
Special Use – SU-1, SU-2, and SU-3	1,010	Designed for land uses of regional importance not otherwise provided for. Among uses are sport stadiums, major education and health institutions, large cultural facilities and other large-scale developments. Permitted uses not specifically stated, as specific uses not predicted. Open space requirements of at least 40 percent. Potential for a Park-and-Ride facility at SU-2 (intersection of Turnpike eastern spur and NJ Route 3). No predicted use at SU-1 (Kearny) or SU-3 (in Kearny Meadows).

Source: Hackensack Meadowlands Development Commission "District Zoning Regulations" current through July 1988.

Table 6.20-2
Empire Tract Zoning Summary

Tract	Zone	Acres	PDC-1	Light Industrial A	Light Industrial B
1	PDC-1	417.96	417.96		
2	PDC-1	42.46	42.46		
3	Light Industrial B	44.69			44.69
4	Light Industrial A	81.63		81.63	
TOTALS		586.74	460.42	81.63	44.69

6.20.3.2 Other Planned Projects

In the vicinity of the Empire Tract, New Jersey Transit is considering the West Shore Commuter Rail Project (see also Section 6.14), and is committed to extending the recently opened Hudson-Bergen Light Rail System from Hoboken in the near future (NJDOT 2000). The recently constructed Vince Lombardi Park and Ride is also operational (see Section 7.14.1.3).

Section 6.20 References

Morgensen, R. 1997. Transcontinental Gas Pipe Line Corporation, Houston, TX. Personal conversation regarding history and construction of TRANSCO pipeline, 10 July 1997.

Hackensack Meadowlands Development Commission. 1998. Application; Vol. V-A June 12, 1998; Drawing DP-5.

Hackensack Meadowlands Development Commission. 1988. "District Zoning Regulations" current through July, 1988.

New Jersey Transit. 2000. Comments on the Meadowlands Mills DEIS, 2000

6.21 NOISE

6.21.1 Noise Fundamentals and Measurement

A number of factors affect sound as it is perceived by the human ear. These include the actual level of the sound (or noise), the frequencies involved, the period of exposure to the noise, and changes or fluctuations in the noise levels during exposure. Levels of noise are measured in units called decibels (dB). Since the human ear cannot equally perceive all pitches or frequencies, these measures are artificially adjusted or weighted to compensate for the human lack of sensitivity to low-pitched and high-pitched sounds. This adjusted unit is known as the A-weighted decibel, or dBA. The A-weighted network de-emphasizes both very low-and very high-pitched sounds so that the measured levels correlate with the human perception of loudness.

Human response to changes in noise levels depends on a number of factors including the quality of the sound, the magnitude of the changes, the time of day at which the changes take place, whether the noise is continuous or intermittent, and the individual's ability to perceive the changes. Human ability to perceive changes in noise levels varies widely with the individual. Generally, changes in noise levels less than 3 dBA will be barely perceptible to most listeners, whereas a 10 dBA change is normally perceived as a doubling (or halving) of noise levels. Noise levels are not additive; that is; introducing a 3 dBA noise to an area with 3 dBA background levels will not produce 6 dBA of noise.

Since the dBA noise metric describes a momentary noise level, and very few noises are constant, other methods to describe noise over extended time periods are needed. One method used to describe fluctuating sound involves describing a fluctuating noise heard over a specific time period as if it is a steady, unchanging sound. For this condition, a descriptor called the equivalent sound level (L_{eq}), can be computed. The L_{eq} descriptor is the constant sound level that, in a given situation and time period (e.g., 1-hour L_{eq}, or 24-hour L_{eq}), conveys the same sound energy as the actual time-varying sound. Statistical sound level descriptors such as L_1, L_{10}, L_{50}, L_{90}, and L_x are also sometimes used to indicate noise levels which are exceeded 1, 10, 50, 90, and x percent of the time, respectively.

An alternative method involves accounting for the responses of people in residential areas to noises that occur during sleeping hours, as compared to noises that occur during waking hours. A second descriptor, the day-night noise level (L_{dn}), is defined as the A-weighted average sound level in decibels during a 24-hour period with a 10 dB weighting applied to nighttime sound levels. It is a widely used indicator for such evaluations. The 10 dB weighting accounts for the fact that noises at night sound louder when compared to day time noises, as noise levels at night are generally lower than during the day. The L_{dn} descriptor has been proposed by the U.S. Department of Housing and Urban Development (USHUD), the USEPA and other organizations as one of the most appropriate criteria for estimating the degree of nuisance or annoyance that increased noise levels would cause in residential neighborhoods.

The maximum 1-hour equivalent sound level (1-hour L_{eq}) is the noise descriptor used in this noise impact analysis. Maximum 1-hour equivalent sound levels provide an indication of the highest expected sound levels.

6.21.2 Noise Standards and Criteria

There are a number of standards and guidelines appropriate for assessing noise impacts in the context of an Environmental Impact Statement. They are useful because they provide both a characterization of the quality of the existing noise environment and a measure of project-induced impacts.

6.21.2.1 Federal Highway Administration (23 CFR 772)

FHWA noise regulations require that a noise analysis be conducted for all highway projects (FHWA 1974). Although these regulations are not directly applicable to the project proposed by Empire Ltd., they have been used in this analysis, as they are the principal federal guidance for the evaluation of traffic-related noise impacts. The FHWA noise regulations contain noise abatement criteria that the FHWA considers to be the acceptable limits for noise levels for exterior land uses and outdoor activities and for certain interior uses (Table 6.21-1). The FHWA guidance on noise abatement criteria categorizes developed land uses as A, B, C, or E. Category B, which includes residences, schools, and hotels and motels, represents the most sensitive receptors that lie in proximity to the Empire Tract. Future noise levels are predicted in order to evaluate the extent of impact in relation to the noise abatement criteria. If these criteria are exceeded, or if there is a substantial increase above the existing noise level, abatement or mitigation measures are considered.

Table 6.21-1
Federal Highway Administration Noise Abatement Criteria

Activity Category	L_{eq}(h)	L_{10}(h)	Description of Activity Category
A	57 (exterior)	60 (exterior)	Land for which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	70 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	75 (exterior)	Developed lands, properties or activities not included in Categories A or B above.
D	---	---	Undeveloped lands.
E	52 (interior)	55 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Note: The L_{eq} and L_{10} designations represent hourly A-weighted sound levels expressed in decibels (dBA). Either L_{10}(h) or L_{eq}(h) (but not both) may be used on a project.
Source: US Department of Transportation, FHWA, 1974.

The FHWA also provides noise sensitivity criteria (Table 6.21-2) to evaluate the severity of noise impacts.

Table 6.21-2
Decibel Changes and Loudness

Change (dBA)	Relative Loudness
0	Reference
3	Barely perceptible change
5	Readily perceptible change
10	Half or twice as loud
20	1/4 or four times as loud
30	1/8 or eight times as loud

Source: Based on Highway Traffic Noise Analysis and Abatement - Policy and Guidance. (FHWA, June 1995.)

The FHWA guidelines permit direct estimation of an individual's probable perception of changes in noise levels; thus, a 3 dBA increase was used in this EIS (See Section 6.21.1) as the threshold for determining noise impact significance.

6.21.2.2 New Jersey State Regulations (NJAC 7: 29-1.2)

New Jersey state noise regulations require that noise levels resulting from industrial, commercial, public service or community service facilities cannot exceed:

- 65 dBA during 7 AM to 10 PM at a residential property line;
- 50 dBA during 10 PM to 7 AM at a residential property line; and
- 65 dBA at the property line of any other commercial facility.

These regulations apply to on-site noise sources associated with development and do not apply to off-site motor vehicle noise.

6.21.2.3 NJMC Regulations

The NJMC has established noise performance standards for the HMD in *Hackensack Meadowlands Development, Subchapter 6: General Provisions*. These regulations apply to on-site stationary noise sources associated with projects developed within the HMD but not to traffic noise from roadways.

These noise performance standards include the following criteria:

- Noise levels should not exceed 55 dBA during 7 AM to 9 PM and 45 dBA during 9 PM to 7 AM in any residential zone, residential specially planned area, or residential planned unit development; and
- Impact noise is considered when noise peak level is more than 6 dBA higher than measured level.

6.21.3 Noise Levels in the Study Area

To assess the existing noise conditions in the vicinity of the Empire Tract, Empire, Ltd. conducted a noise measurement survey (PS&S 2001). Two noise monitoring locations were selected in close proximity to potentially sensitive receptors (e.g., residences and motels) located in areas potentially most affected by project related traffic. The monitoring locations are identified on Figure 6.21-1 and described in Table 6.21-3.

Table 6.21-3
Noise Monitoring Locations

Location Number	Description of Location
NM-A1	The Hampton Inn on Paterson Plank Road, 120 feet from the side of the roadway.
NM-A2	The Fairfield Inn on Paterson Plank Road, 75 feet from the side of the roadway.
Source: PS&S 2001.	

The results of the monitoring are presented in Table 6.21-4. Existing noise levels were monitored at two locations during the peak A.M. traffic hour (7:30 a.m. to 8:30 a.m.) because the maximum total traffic volume is expected to occur during this period. Noise levels measured during AM peak traffic hour are expected to be similar to those measured during PM traffic hour for background conditions. Noise monitoring data was collected in one-minute records of sound pressure level readings for 20-minute periods at each noise monitoring location. The 20-minute equivalent sound level (L_{eq}) was computed for each data set. Noise levels during the Peak Traffic AM Highway Hour (7:30 - 8:30 AM) ranged from 61.7 dBA to 63.7 dBA at locations NM-A1 and NM-A2, respectively.

Table 6.21-4
Noise Monitoring Results[(a)]

Noise Monitoring Location	Monitoring Time Period	Distance from Nearest Roadway (ft)	Noise Level Leq [(b)] (dBA)
NM-A1	7:30 to 7:50 AM	120	61.7
NM-A2	8:10 to 8:30 AM	75	63.8

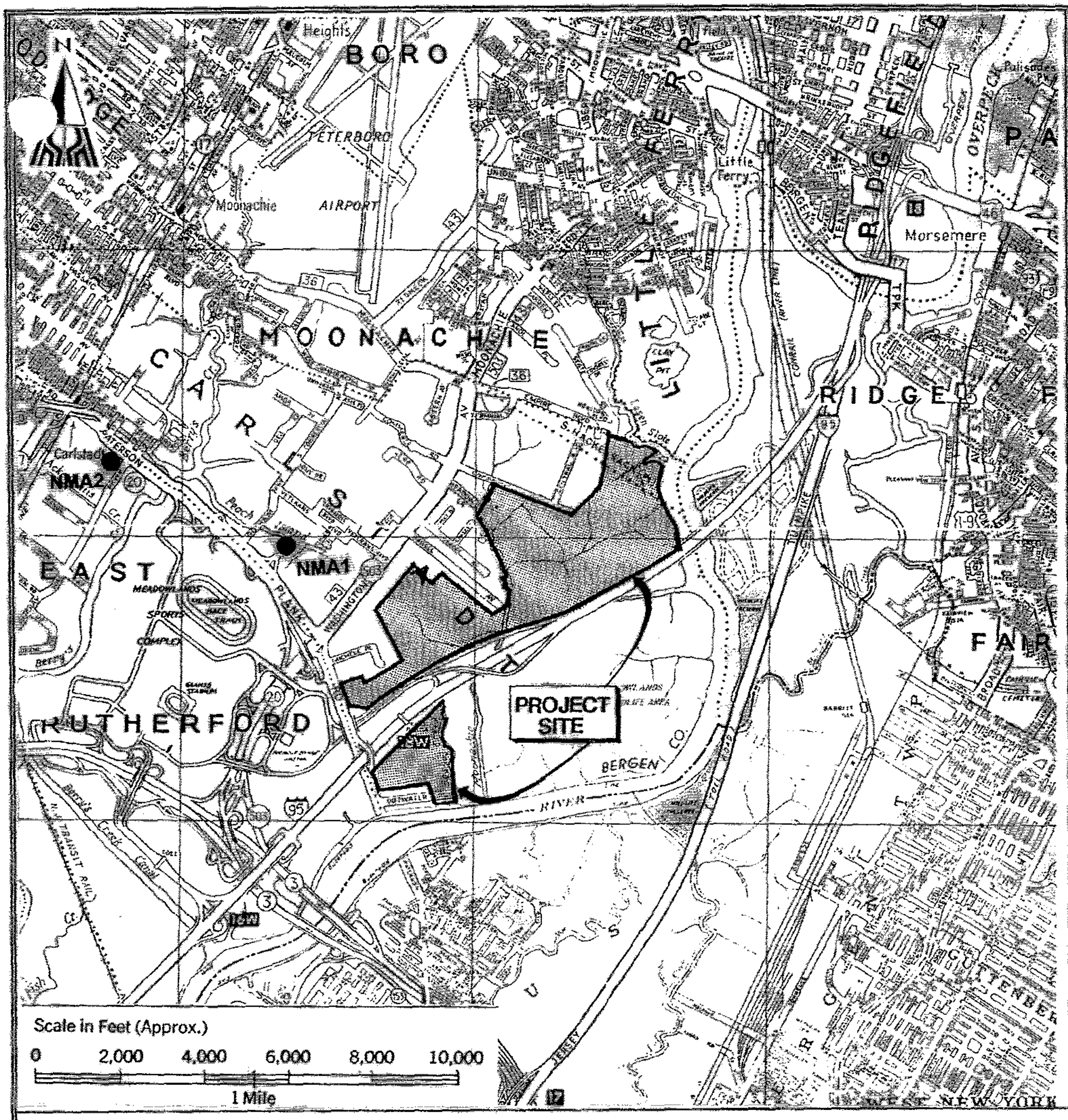
Notes:
(a) Noise monitoring was performed in June 2001.
(b) Noise results are Leq values over the 20-minute monitoring period.
Source: PS&S 2001.

6.21.4 Verification of Traffic Noise Prediction Model

Noise monitoring sites NM-A1 (Hampton Inn) and NM-A2 (Fairfield Inn) were used to validate a traffic noise model to predict noise levels at additional locations where monitoring data was not collected. FHWA STAMINA 2.0 Model input used for this validation included traffic volume data from the corresponding 20-minute manual traffic counts collected by RKA (TRC RKA 2001b) concurrently with the noise monitoring. The comparison between the noise modeling results and the noise monitoring data demonstrated that the model over-predicted by 2.6 and 1.6 dBA for NM-A1 and NM-A2, respectively. This comparison is shown in Table 6.21-5.

Table 6.21-5
Comparison of Modeled and Measured Noise Levels

Noise Monitoring Location	Modeled Noise Level (dBA)	Monitored Noise Level (dBA)	Difference (dBA)
NM-A1	64.3	61.7	2.6
NM-A2	65.4	63.8	1.6
Source: PS&S 2001			



LEGEND:

● NMA1 = NOISE MONITORING LOCATION No. 1

SOURCE:
ION OF HAGSTROM
GEN COUNTY MAP

NOISE MONITORING LOCATIONS
MEADOWLANDS MILLS
BERGEN COUNTY, NEW JERSEY

Scale: AS SHOWN	Date: JUNE 2001	Figure 6.21-1

Section 6.21 References

FHWA (Federal Highway Authority). 1995. *Highway Traffic Noise Analysis and Abatement-Policy and Guidance.* Washington, DC.

FHWA (Federal Highway Authority). 1974. *United States Department of Transportation.*

Paulus, Sokolowski & Sartor, Inc. 2001. Mobile Source Noise Impact Assessment for the Meadowlands Mills Project Based Upon Information in the May 2001 Traffic Impact Study.

6.22 INFRASTRUCTURE

This section pertains to current infrastructure within the vicinity of the Empire Tract, as the site is presently undeveloped.

6.22.1 Potable Water Supply Facilities

The potable water supply system serving the area surrounding the project site is maintained and operated by United Water New Jersey (formerly known as the Hackensack Water Company, Inc.). The source water is conveyed from four large impoundment reservoirs in northern New Jersey and southern New York State. Of these, the Oradell Reservoir, located in the Borough of Haworth, is the primary source of water to the area within the vicinity of the Empire Tract. Oradell Reservoir water is treated by a water treatment plant located on the eastern shore of the reservoir. Currently the nearest well that contributes to the United Water New Jersey system is located in Upper Saddle River, New Jersey, more than 15 miles to the north of the project site.

The project area is served via 20-inch and 12-inch water distribution mains located beneath Washington Avenue. In addition, there are 12-inch mains beneath many of the surrounding roads, including Empire Boulevard, Commerce Boulevard, and Meadow Lane.

Likely connection points for any proposed projects in the immediate vicinity of the Empire Tract have been identified by United Water New Jersey as follows (Federico, March 18, 1997):

- 12-inch and 8-inch water mains beneath Paterson Plank Road;
- a 12-inch water main beneath Michelle Place;
- an 8-inch water main beneath Jomike Court; and
- a 12-inch water main beneath Barrel Avenue.

Results from a pressure test in the vicinity of the aforementioned connections indicated that the water pressures in pipes located near the Empire Tract range from 95 to 98 pounds per square inch (psi) (Federico, April 18, 1997).

6.22.2 Sanitary Sewage Treatment Facilities

The area in which the site is located is served by the Bergen County Utilities Authority (BCUA) (see Figure 6.22-1). The BCUA wastewater treatment plant (New Jersey Pollutant Discharge Elimination System [NJPDES] Permit No. NJ0020028) is located less than 1 mile northeast of the site, in the Township of Little Ferry. The BCUA planning area has a year 2010 estimated population of 550,000 people, as set forth in the Northeast New Jersey Water Quality Management Plan.

The BCUA wastewater treatment plant treated approximately 70 to 80 million gallons per day (mgd) of sewage flow in 1997. Treatment plant expansion has been completed, and the plant now has an upgraded physical capacity of 109 mgd. For the year 2010, the estimate of anticipated average daily flow is 85 mgd, which includes an allowance of 23 mgd for infiltration/inflow (I/I).

6.22.3 Energy Supply

The energy requirements, including electricity and natural gas, for the project area are currently supplied by the Public Service Electric and Gas (PSE&G) Company. Electrical energy presently supplies the industrial demands of the project area from transmission lines located at Washington Avenue, Paterson Plank Road west of the New Jersey Turnpike, and beneath Empire Boulevard and Meadow Lane.

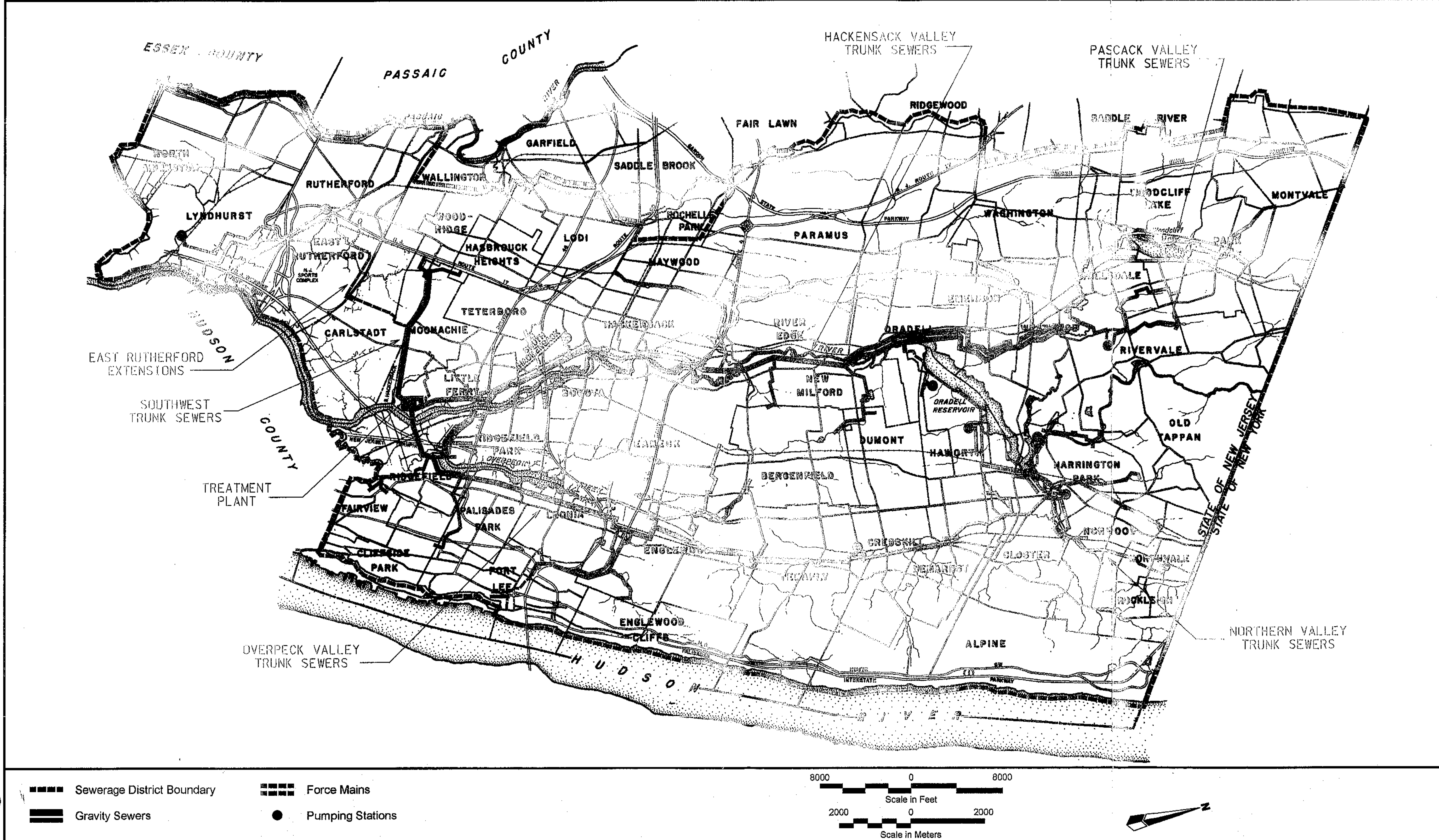
Electrical power to the area of the site is supplied via PSE&G's major substations in Ridgefield and East Rutherford. Natural gas is supplied to the area of the site by an existing network of gas mains.

6.22.4 Solid Waste

The BCUA is the managing agent for the collection and disposal of solid waste and recyclable materials generated in the vicinity of the site. The methods of collection and disposal of solid waste generated in the area are subject to state guidelines. These guidelines include an extensive recycling ordinance, which requires certain glass, metal, paper, and plastic waste to be recycled.

The Empire Tract is currently undeveloped; therefore, no solid waste is generated on site.

BCUA Service Area



Source: Bergen County Utility Authority, 1997.

Figure 6.22-1

Section 6.22 References

Federico, P., Manager, Facilities Extension and Planning, United Water New Jersey. Personal Letter Correspondence with Drake Stinson of TAMS Consultants, Inc. March 18, 1997.

Federico, P., Manager, Facilities Extension and Planning, United Water New Jersey. Personal Telephone Conversation with Drake Stinson of TAMS Consultants, Inc. April 18, 1997.